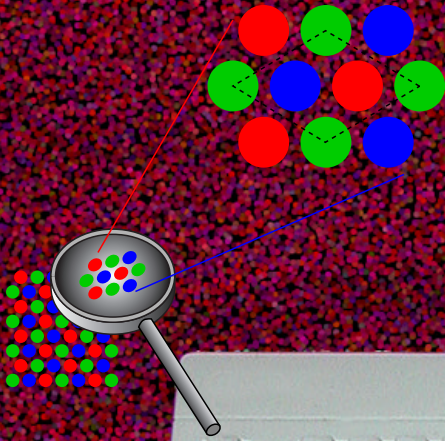


A Close Look at Modern Keyboard/Video/Mouse Switching

by Tony DeKerf and Gary D. Davis

Copyright 1995, 2000 by
Tron International, Inc., San Mateo CA 94402
and
The WorkCenter Corporation, Topanga CA 90290
All Rights Reserved



\$1,500⁰⁰ U.S. Per Copy

INTENTIONALLY LEFT BLANK

Contents

What is KVM Switching?	1
What Are KVM Extension Products?	2
Why You Should Be Using These Products	3
• Facilities Managers Can Save Space and Power, and Improve Work Flow	3
• LAN Administrators Can Save Time, Simplify Management and Fit More in Available Space	3
• Benefits to Software & Hardware Developers	5
• What if You Have Dumb Terminals?	6
• Addressing a mix of PCs, RS/6000, Mac, Sun, HP, Dec Alpha, SGI and/or other Platforms	6
• Office Settings Gain Security and Save Space with KVM Extension and/or Sharing	6
Video & Keyboard Circuitry — A Non-Technical Overview	8
• Video	8
• Digital Video for PCs	9
• Analog Video for PCs	9
• Macintosh Video, Past and Present	9
• Sun Video, Past and Present	10
• SGI Video	10
• NTSC Video	11
• Keyboards, Mice, Wheel Mice, Trackballs, Trackpads	11
How Does a Keyboard/Video Switch Work?	12
• Passive Versus Active Switches	12
• How Does the Active KVS Work?	12
Single and Multi-Console Switches	15
• Unified Versus Split Bus Architecture	15
• Single Versus Multi-Console (and Multi-Access)	16
• Single Versus Multi-Platform KVM Switches	17
Product Function for the Technically Oriented Reader	18
• Keyboard Switching	18
• Mouse Switching	20
• History of the Mouse	20
• USB Connections	22
• What it takes to deliver a Good KVM Switch	22
A Video Refresher	24
• Color Depth	24
• Sync	24
• KVMS Video Signal Processing	25
• Monitor Types & Standards	27
• NTSC Video is Not Optimum for Computers	31

Other KVMS Factors	32
• Operating System Considerations	32
• Computer Hardware Considerations	32
• Methods of Switching	33
• Other Issues to Consider	34
Multi-Console KVMS Systems – The New Standard	35
• The Explosion in Multi-Console Switching	35
• Architecture	35
• Physical Considerations	40
• Platform Support	40
• Controlling and Tracking Usage in the KVM Switch System	41
• Emulation Services	41
• Capacity and Scalability	42
• Extending the Distance – Local and Long Distance	43
Dollar Factors – Obvious and Hidden	46
• KVMS Direct Costs	46
• Cables	46
• KVMS Reliability and Support Costs	47
• Efficiency and Productivity-Less Tangible But Very Significant Sources of Savings	47
Appendices	
• A. Connector diagrams/pin outs/functions	49
• B. KVMS Glossary	51
Who Created This Document	78

What is KVM Switching

A Keyboard/Video/Mouse Switch (KVMS) is also known as a Keyboard/Video Switch (KVS) — same thing. These devices allow multiple computers to share (sequentially) one keyboard, monitor and mouse. In recent years, more advanced multi-console switches have become popular. They support multiple data paths so that two or more monitors, keyboards and mice can address any of the connected computers... same concept, greater flexibility.

While the concept itself is simple, KVMS technology has evolved only recently. It was introduced in rudimentary form during the late 1980s and has matured during the 1990s.

Why was KVMS technology developed? Why it has been growing so rapidly in popularity? Isn't it really pretty easy to build such a switch? As you read this document, you'll find the answers to these questions, and some others you've probably not yet considered.

NOTE: Originally published in black-and-white print, this Second Edition is offered primarily as an Adobe PDF file (Portable Document Format) so that we can use full color illustrations for clarity, avoid arbitrary printing-form related page limits, give you the benefit of hyper-text links, and update the content more frequently as ongoing technical developments may warrant. (If you're reading a printed version, it may have been sponsored by one of the industry's leaders under license from the authors, or it may have been printed by someone who paid the licensing fee to unlock the PDF file for printing purposes.) We suggest that you visually scan the pages quickly at first, then use the hypertext links to jump to sections that interest you. We see many changes in the future KVMS industry. This document, and its subsequent revisions will remain a valuable reference; be sure to visit the websites (www.tron.com or www.TheWorkCenterCorp.com) periodically to download the latest version (one purchase of the unlocked PDF document validates future version updates; if you don't purchase the unlock code, you can still access summary information but you won't have the whole story).

The driving force behind KVMS' development was the rapid deployment of local area networks (LANs); relatively rapidly client-server software with microcomputers on each desk replaced the old Mainframe/terminal/mega-application paradigm. With LANs came a massive proliferation of servers in the data center — lots of boxes and nowhere to put them all. The KVMS was a welcome development because it eliminated a lot of those boxes (monitors) and a lot of the needed desk space (for keyboards).

If you haven't given it much consideration, you might think, "What's the big deal? Why not just stuff a pushbutton or rotary switch with enough contacts and the right sets of connectors into a box and hook it all up?" Presumably, you could then use this gadget to switch a keyboard, monitor, and maybe a mouse from one computer to the next. Actually that's pretty much how early KVMS operated (well, actually, the earliest switches didn't need to accommodate a mouse, which is why our first edition was called "The KVS White Paper"). Unfortunately, this was neither an elegant or a reliable solution. For a variety of reasons you'll soon discover, the purely mechanical (or passive) KVMS was very limited and few are still in use. Passive KVMS are rarely sold today. Instead, much more sophisticated, active electronic switches dominate the KVMS market.

We wrote and published the first edition of "The Keyboard/ Video Switch White Paper" in 1995. We appreciate the warm reception it was granted by manufacturers, media and equipment users alike. In the interim, many new products and product refinements have come to the market. As in the past, we welcome your comments, suggestions and corrections (yes, we know we're not perfect, though we've done our best to ensure accuracy and fairness). We also ask that you honor our efforts and our copyright, and not reproduce or distribute (electronically or otherwise) any part of this document for any purpose without our express written permission (except the use of excerpts for critical review by the Press, which we welcome). In short, use for your own reading, but don't make multiple copies. The authors have spent months and months of valuable time creating this document, and we'd like to profit fairly from our efforts

What Are KVM Extension Products?

It is often useful to extend the distance between a computer (or a KVM switch) and the monitor, keyboard and mouse to which it is connected. Ordinary extension cable will work reliable to 10 or 15 feet. Higher quality video cables can work as far as 50 or 100 feet if the resolution requirements are not extreme, but keyboard and mouse extension just won't flow through a cable at that distance. Technical issues of signal timing and level cause errors or just plain failure to function at all.

Typically, video quality does decline with a given unit as the cable length increases... up to the point where video and/or keyboard-mouse response becomes unusable. However, at a given distance within the "supported range," whether 100 feet or 500 feet or 1000 feet, different products yield very different results. Also, some KVM extenders do a better job with mouse or keyboard emulation than do others, and the results can vary with specific computer or KVM switch interfaces. As is



This is not exactly what we mean by KVM Extension

Engineers responded to the need for longer distance extension (beyond 25 or 50 feet) by developing specialized electronic devices which we characterize as KVM Extension Products. In most cases these devices are comprised of a transmitter at the computer (or KVM switch) and a receiver at the keyboard/monitor/mouse location. These devices employ special active signal processing with local loop-back and/or impedance conversion to avoid timing problems with keyboards and mice. They also use video line driver amplifiers to deliver video to the monitor at greater distances while avoiding excess quality loss. Some KVM extenders require specialized cabling, possibly even fiberoptic cable, while a number of more recent products utilize ordinary Category 5 (Cat 5) network cable.

Various brands and models of KVM Extenders are built to work over different distance ranges.

the case with KVM switches, you need to test a given extender with the particular devices you wish to extend to be sure it will work satisfactorily in your application; always ask for a money-back or exchange guarantee.

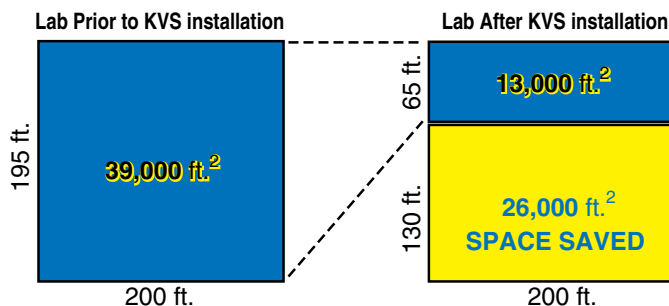
KVM Extension Products make a very useful adjunct to a KVM switch system, allowing certain computers or user control consoles to be placed at a greater distance from the switch than would otherwise be possible. Moreover, KVM extension products can provide greater security in that they allow one to keep those switch components that might allow a breach of security to remain inside a locked cabinet inside a locked data center.

Why You Should Be Using These Products

Keyboard/Video/Mouse Switches (KVMS) solve problems for facilities managers, LAN/WAN administrators, developers of hardware and software, and for anyone who wishes to control multiple platforms with a single monitor and keyboard. Some switch models now are built to address multiple RS-232 controlled devices (including mini-computers, mainframes, intelligent hubs, routers, telephone key systems, and voice mail systems) from a single dumb terminal, or from a telnet interface. Some KVMS systems let you mix conventional keyboards/monitors/mice *and* terminal emulation to address a mix of RS-232 and keyboard/video/mouse (frame buffered or graphics adapter) controlled devices. Let's examine some of the benefits.

Facilities Managers Can Save Space and Power, and Improve Work Flow

KVMS lets you put a lot more computers in a given space, or to use much less space for a set number of computers. In one lab, for instance, IBM Corporation installed KVMS and went from 39,000 square feet to 13,000 square feet — a reduction of 67% in required floor space! Imagine what you could do with that kind of space savings. (You can slash floor space requirements even more dramatically by combining special computer racking systems with KVMS.)



Because KVMS lets you use far fewer monitors, your monthly power bills will be much lower. The typical 17-inch VGA color monitor, for example, draws about 1.3 amps, or 150 watts of power. With a typical KVMS controlling 8 computers from a single monitor, you reduce the monitor count by 82%. In a server room or lab operating around the clock, 8 monitors would use 28.8 kilowatt hours (kWh) per day, whereas the single monitor would use just 3.6 kWh per day. That 25.2 kWh saved each day amounts to about 9,200 kWh annually. A

typical California small-business Electric bill runs from 10 to 15¢ per kWh. That calculates to be from \$920 to \$1,380 a year saved in direct electrical consumption — but you actually save a lot more.

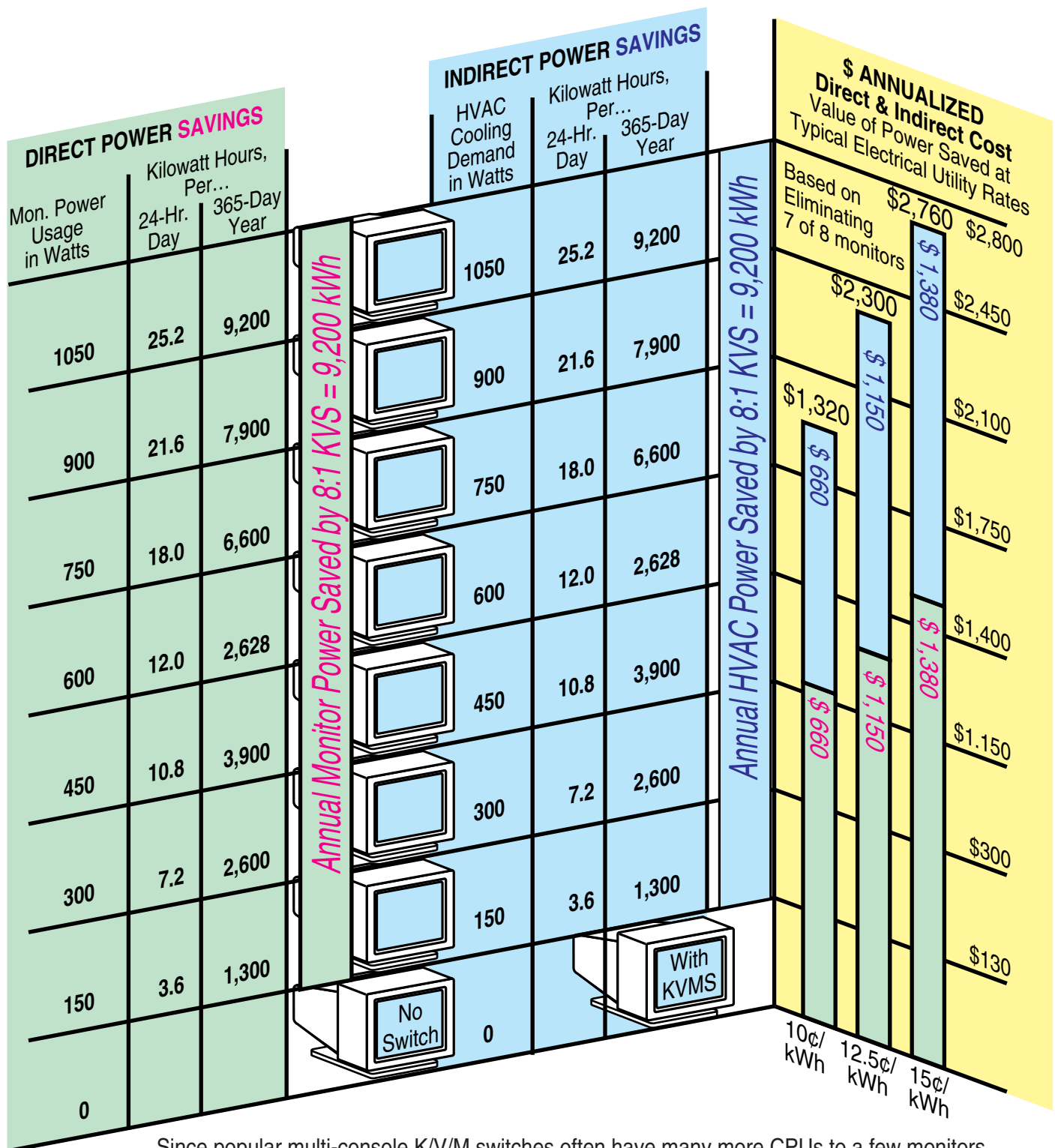
First, larger systems will typically have more than 8 CPUs per monitor, so the numbers improve there. In addition, you save in air conditioning costs because you don't have to remove the BTUs (British Thermal Units, or heat) generated by those eliminated monitors. That same 17" monitor which draws 150 watts generates about 500 BTUs. To prevent heat build-up about 150 watts of air conditioning is required, so the annual HVAC (heating/ventilation/air conditioning) power savings for this 8:1 KVMS setup will be another 9,200 kWh, which saves you another \$920 to \$1,380 annually. 'Green' monitors that shut themselves down would use less power so your savings would be less, but larger monitors (now more common with GUIs) use more power so you'd save more. Like they say in the automotive EPA mileage analyses, "your results may vary."

Adding the HVAC and direct power savings, and averaging the power rate to 12.5 cents/KwH, the power savings alone of an 8:1 keyboard/video switch, in one year, will be about \$2,300. To this, add the savings in floor space, and you can see the switching will just about pay for itself in the first year of operation. There are actually much greater savings for your company if you consider capital acquisition and maintenance for the keyboards and monitors, and a measurable increase in operator productivity.

LAN Administrators Can Save Time, Simplify Management and Fit More in Available Space

When a monitor and keyboard is attached to every CPU in the data center, the operator typically must walk up and down long aisles of computers to review the operating status of each server, bridge, router, etc. If we instead use a Keyboard/Video/Mouse Switching system to create a one- or two-seat console for dozens of servers, we make the manager's task much easier.

If you're the operator, you will really appreciate how much more relaxed you feel at the end of the day.



Since popular multi-console K/V/M switches often have many more CPUs to a few monitors the dollars saved on power may be significantly higher than those shown here (greater than 7:1 ratio)

Because an operator can access data and examine system status with the touch of a finger, instead of standing up and walking around to locate the desired monitor and keyboard, productivity increases measurably. If you're the operator, you will really appreciate how much more relaxed you feel at the end of the day.

You will save a tremendous amount of physical space by using KVMS. Particularly as you add servers for burgeoning web servers, e-mail systems, fax servers, etc., you will appreciate the ability to do so without having to provide space for more monitors and keyboards. A 50% reduction of floor space is typical when using KVMS, and you can get down to as little as 25% of the original floor space if you combine specialized computer racking systems with KVMS.

Saving space certainly matters, and related to that is a reduction in clutter. With fewer components physically scattered around the data center or lab, it is easier to maintain the remaining equipment. It becomes far less likely that a stashed keyboard will slip off its precarious perch on an overcrowded desk. And there will be far less cost associated with annual maintenance of keyboards and monitors.

A 50% reduction of floor space is typical when using KVMS, and you can get down to 25% the floor space if you combine specialized racking systems with KVMS.

If you are installing new systems, often the cost of the KVMS will be offset completely by the money saved on monitors, keyboards (and mice if you use them). For example, a decent quality 17 inch VGA monitor sells for about \$350, and a 101-key keyboard with a mouse goes for \$35 to \$60. Let's suppose you eliminate seven such monitors and keyboards with a single 8:1 KVMS. The switch and cables can cost under \$1,200. The monitors and keyboard savings are about \$2,800 – an immediate savings of about \$1,600. [If those were high-resolution, pricey graphics monitors you eliminated, your savings would be far greater!] Your savings may be reduced slightly if the keyboards come with the computers, but you still have the ongoing power and maintenance savings we have previously described, so the basic keyboard/video/mouse switch not only pays for itself right away, it pays you back big dividends year after year.

Benefits to Software and Hardware Developers

The developer must test his software or circuitry on a variety of computers. For this reason, the typical developer's office is, itself, a mini-lab equipped with two to four workstations. A 10 x 10 foot or 12 x 12 foot cubicle can become very crowded – where ARE you going to put the file cabinet? The guest chair? The answer is to use KVMS!

An economical 4-port keyboard/video switch (\$150 to \$800 depending on the platforms supported, user interface, physical construction, expandability, etc., plus cables) enables the developer to place a single monitor and keyboard on his or her desk... in a comfortable, easy-to-use position. There is still room for reference documents, a telephone, even a photo of the family.

For the developer who is operating a large lab, the benefits of KVMS are substantial.

Space savings and increased productivity, due to operator comfort, are clearly justifications for KVMS in the developer's office. KVMS also reduces one's exposure to electro-magnetic and electro-static radiation. While recent revelations of fraud in earlier studies undermined arguments about the dangers of such exposure, the actual hazards associated with ELF and VLF fields (Extremely Low Frequency and Very Low Frequency) remain unknown. Do they lead to metabolic changes on a cellular level? Do they cause cancer? Do they cause eyestrain? While the answers are arguably inconclusive, it is certain you will reduce the direct exposure to a potential hazard by reducing the number of monitors in close proximity to the operator.

For the developer who is operating a large lab, the benefits of KVMS are substantial. You will save a huge amount of floor space... in some cases making the difference between being able to fit the lab in your current facility or having to look for a new building. Additionally, you need only refer to the prior discussion for LAN Administrators to understand that the equipment and maintenance cost savings apply equally in the lab.

Some KVMS manufacturers provide the ability to remotely locate the KVMS from the computers or to allow dual (or multiple) operators access to the same KVMS-connected computers. With remotely located access to the switch, it becomes possible to bring a lab full of computers to the developer's office desk where they can be accessed (and rebooted) by a single keyboard and monitor without hav-

ing to use any network hardware or software (you get to the “blue screen” boot with “out of band” KVMS, unlike LAN/software or “in-band” server access solutions).

Is KVMS for every situation? Frankly, no. However, there are many ways to approach KVMS, and we encourage you to evaluate it carefully, with currently available technology, to make sure you are taking advantage of the best technological solution to your needs.

What If You Have a Mix of PCs and Serial Terminals?

Currently, if you have to access data processing resources via serial (or “dumb”) terminals and communications lines, and you also have to access servers or workstations locally via video and keyboard connections, you must have at least two monitors and keyboards — often many more. Products have been developed that integrate terminal-emulation with direct PC-connections. These products enable you to reduce a mix of terminals and PC monitors and keyboards to a single or a few consoles. In some cases there is a protocol conversion from terminal mode (ASCII/RS-232) to VGA/PS2 within the switch and in other cases external protocol converters are employed. Additionally, it is possible to launch a terminal emulator on a standard PC and to bring that PC into a standard KVM port. Since this latter solution is primarily a software add-on, it can be more cost effective than external converters which typically cost in the neighborhood of \$500 per port. Switches that are built specifically for terminal control may substantially less per port, but don’t support conventional KVM systems. Switches that support a mix of conventional KVM and terminal connections (without external converters) typically cost about the same as using external converters, but are easier to set up and more reliable since there are fewer cables and parts involved.

Use One Interface to address a Mix of PCs, RS/6000, Mac, Sun, HP, Dec Alpha, SGI or other Platforms

Today’s complex network environments often call for a mix of servers, including Intel-based or clone x86 platforms, Macintosh platforms, Dec Alpha and/or Sun Sparc and Enterprise platforms. Video and film effects production facilities often add high-power SGI (Silicon Graphics) processors to the server or workstation mix. Conventional

KVMS systems have been available to switch any one of these platforms, but until a few years ago, you would still need at least one monitor, keyboard, and mouse (or other control device) for each of the different architectures.

Today several KVMS products include the necessary conversion capability so that a single monitor, keyboard and mouse can be used to control a combination of PC, Mac, Dec, HP and Sun platforms. There may be some restrictions as to specifically incompatible models so be sure to check carefully to ensure your computers are supported by a given switch model (and if they are supported, ask whether external converters are required, or if support is native, which means “built in”). Some KVMS products also enable you to add serial terminals to this mix.

The benefits of reduced monitor and keyboard count... space savings, power savings, ease of control... thus encompass the broadest range of platforms. You also avoid the need for a proliferation of different keyboards and mice, which typically are the most difficult peripherals to actually locate comfortably within a given user’s reach.

Office Settings Gain Security and Save Space with KVM Extension and/or Sharing

The KVM extender can provide excellent security and save space in offices. Instead of placing dozens to hundreds of workstations in crowded office cubicles, a number of enlightened facilities and IS managers are moving the workstations into closets or even into the data center itself. They efficiently and securely rack up the workstations in data cabinets, and use KVM extenders to “throw” the keyboard, monitor and mouse out to the offices. Since only a single piece of Cat 5 cable is needed per office drop. Often existing ethernet connections can be re-deployed for KVM extension. Then the connections from workstation to hub are easily replaced with short Cat 5 cables at the workstation rack, thus avoiding any need for pulling new cables through the facility.

With this centralized architecture, theft of chips or entire workstations drops to near zero, installation of unauthorized software is less likely, and theft of data is reduced. Unless a worker has a need to frequently install media in the workstation, he or she won’t miss the CPU... they’ll instead applaud the quieter, cooler, less crowded office. While it

may cost \$400 to \$900 to install the extender, the payback is worthwhile and can be immediate.

Extension provides additional convenience in multi-shift operations where a given office can be “patched” or switched to a different workstation. That same extended KVM connection can go to a switch in the data center where the person in the office may be given administrator-restricted direct access to additional workstations and/or servers.

In studio production/post production environments, extension products and switching allow expensive graphics platforms (like SGI and Avid platforms) to be located securely in an easily maintained machine room, with their control selectively deployed to those studios in which they are required. High-resolution KVMs and extension systems, with the possibility of multiple video connections per CPU, support these demanding applications.

Video, Keyboard and Mouse Circuitry

— A Non-Technical Overview —

To understand how switches function, it is helpful to understand something about video and keyboard circuitry. In the following paragraphs, you will find an overview of the types of video signals, and what the various acronyms mean. You will also learn a little about keyboard functions and how switches (and computers) deal with the keyboard. Relax – you don't need to know much about electronics or math to comprehend this discussion. Monitor, keyboard and mouse functions are generally transparent to the user, and only matter when you are purchasing components, assembling a system, and initially setting it up. They do matter to the switch, though, as you will learn. If you want to know more about these video and keyboard functions, see [Product Function for the Technically Oriented Reader](#).

Video

Three primary considerations for handling video signals are the resolution, color depth, and refresh rate(or sync frequency). *Resolution* describes the number of dots that can be displayed horizontally and vertically on the monitor screen. These dots are technically called picture elements, or *Pixels*. *Color depth* refers to the maximum number of colors that can be defined and displayed at once. Vendors discuss color depth either in bits of data they use to define the colors (i.e., 24-bit color) or as a numeric value for the numbers of colors that are available (i.e., 16 million colors). *Vertical Sync Frequency*, which is the same as *Frame Rate* or *Refresh Rate* on [non-interlaced displays](#) and indirectly related to the Horizontal Sync frequency, describes the number of times per second the screen imaged is updated (refreshed). The important factor here is that you cannot mix video cards based on one sync frequency with monitors based on another unless the monitors are “multi-sync,” which means they can synchronize to different video refresh rates (and often to different resolutions). In today's marketplace, most monitors are of the multi-sync variety, though they vary widely in rated capability. If the screen goes black when your KVM switches to a particular computer, you may have a bad connection or a technical problem... or it may just be that the computer is putting out a signal which that

particular monitor cannot accommodate (you can sometimes check this by connecting the monitor directly to the computer's video output; if it works in a direct connection, then there's a switch system problem).

The digital representation of the color may be fed directly to the monitor for interpretation, and often is with flat panel displays, but more often the video driver card converts it to a modulated analog signal (i.e., one continuously varying in voltage rather than defined by numbers), and this analog signal goes to the monitor.

Digital Video for PCs

Early PC monitors utilized TTL signals (Transistor-Transistor Logic) to convey video from the display adapter card to the monitor. These are 5-volt digital signals, with the video intensity defined by a numerical value. The TTL monitor's internal circuitry includes digital-to-analog converters (DACs) and amplifiers to map these digital signals onto the screen in the correct position and at the appropriate intensity.



DB-9 Connector Used for TTL Video Connection

While the term “TTL-based video” may not be familiar, you may have heard of MDA (Monochrome Display Adapter), CGA (Color Graphics Adapter) and EGA (Extended Graphics Adapter) cards. These cards are all TTL-based and they typically use DB-9 (9-pin D-connector) outputs.

Interestingly, while the earliest PCs used digital video, some of the most modern models are moving back to the digital realm — only not using MDA/CGA/EGA standards. You'll see this in high-resolution flat panel displays (such as Liquid Crystal Displays and Plasma Displays) as well as in some monitors that utilize Universal Serial Bus (USB) interfaces. Some video driver cards are now being made to drive digital-ready CRT (cathode ray tube, i.e., conventional) monitors (not necessarily USB-

standard) as well. With modern high-speed, low-cost digital circuitry, it has become possible to get more accurate high-resolution images by keeping signals in the digital domain rather than converting them to analog... or if analog conversion is done, it occurs right inside the monitor.

Analog Video for PCs

Further along in PC development, manufacturers began to use analog signals to convey video from the display adapter card to the monitor. Here, the video intensity is defined by a continuously-variable voltage that typically ranges from zero to 700 millivolts (mV) DC per color. The monitor includes circuitry to map these signals onto the screen, and amplifiers that deliver the appropriate intensity.

Analog-based video encompasses VGA (Versatile Graphics Array), SVGA (Super VGA), and XGA (Extended Graphics Array) cards, among others.

Today's analog cards typically have much higher resolution (more pixels displayed) than older TTL cards.



HDD-15 Connector Used for Analog (VGA/SVGA) Video

Technical details may not matter to you, but this does; you cannot directly connect a TTL video card output to a VGA monitor, or vice-versa. First of all, the cables do not mate, but if you were to somehow wire up an adapter, you would fail to see the correct image, and you could easily damage the monitor's or video card's

circuitry; analog signals peak at 0.7 to 1 volt, not 5 volts like TTL digital. Analog cards typically use HDD-15 (15-pin D-connector with 3 rows of pins) outputs. Not all 15 pins are used for signals, but in XGA-II video some of these pins are used to convey coded information about the monitor back to the video card.

Macintosh Video, Past and Present

The Macintosh series of computers from Apple have evolved along a different path than PCs, but there are many similarities. Early Macs (from 1984 to about 1987) had built-in monochrome video (the Mac, Mac 512, Mac Plus, and Mac SE). First via third-party adapters, and subsequently through

Apple's own designs as well, plug-in video adapters made it possible to use larger external monitors — color, gray scale or monochrome. The Mac SE and all subsequent Mac II and Power PC Macs have incorporated this capability (although the newer iMac is the first recent Mac to rely primarily on a built-in video display).



DB-15 Connector Used for Early Macintosh Video

Depending on the third party vendor, the interface between the adapter card and the monitor will vary; DB-15 and HDD-15 are most common, but some video card and Mac monitors made use of single or multiple BNC (coax) connectors. Apple also



BNC Connectors Used for Some Mac, SGI, RS/6000 and Special PC Video Cards

supplied built-in video circuitry on the motherboard with external video output on a number of platforms, including the Mac IIcx, Mac IIci, and most of their 68040 ("Quadra" and "Performa" series) and the majority of Power PC platforms (the latter sometimes using plug-in

video cards). The color depth varies from monochrome to 16.7 million colors, and screen resolution varies as well. For this reason, and because the Mac operating system relies on a GUI (graphical user interface), all but the earliest Mac models return information from the monitor (or video card) to the operating system. Video sense data indicates the resolution and color depth of the monitor being used so the operating system can render its windows appropriately.

These complexities are a key reason why a Mac KVM was not introduced until several years after PC switching became available. Until very recently, the Macintosh's keyboard and mouse signals were also defined by a different electronic standard (the ADB, or Apple Desktop Bus), which is why an ordinary switch cannot be used to handle Macs and PCs together.

Finally, the very latest Macintosh models, including the iMac and the new G3 Yosemite models, as well as the latest Powerbooks, include

USB (universal serial bus) connections that can be used for mouse, keyboard and even video connections (as well as modem i/o and other functions). Most of these models have redundant Mac-standard ADB keyboard/mouse and both DB-15 (Mac) and HDD-15 (VGA) video connectors (or HDD-15 built in and DB-15 via an adapter), preserving some backward peripheral compatibility; the latest G4 Macintosh does not have ADB capability and relies solely on USB for keyboard/mouse interface, although third-party adapters are available to convert USB to ADB or PS2 type connections.

In fact, there is a growing trend among PC makers as well to eliminate so-called “legacy” connections for keyboard, mouse and other peripherals and to replace these with USB and Firewire connections. This is a smart move because old, inefficient drivers are being replaced with modern, high-speed code and hardware. Apple was among the first to promote USB technology.

Sun Video, Past and Present

The Sun Sparc platform is a RISC-based (Reduced Instruction Set Computer) workstation or server that typically is equipped with a high-resolution monochrome or color monitor. Sun has sold their own monitors that match their keyboard buffer/video card refresh rates, color depth and resolution. Sun color monitors have traditionally employed special 13W3 connectors with three coaxial conductors and ten additional pins, providing R-G-B video as well as two-way sense data. Such monitors and cables are expensive. Some who use Sun platforms for servers prefer to take advantage of a serial output on the Sun unit.

Sending serial data to a serial terminal does not produce the same high-resolution, high data rate image, but for a server this is often perfectly acceptable, and the advantages are not only a cost savings in the monitor, but also reduced demands on the CPU for video I/O (input/output) functions, freeing the CPU to do a better job of “serving.” Another potential benefit of serial video/keyboard control via a terminal connection is security against “hacking”



13W3 Connector Used for Some Sun and SGI Video Connections. Sun Now Moving to HDD-15, and SGI also Uses BNC and HDD-15

by virtue of an non-breakable administrative control path.

Switching Sun video has required a switch that is capable of sufficient bandwidth, and that has the proper connections, to accommodate the Sun monitors. The Sun keyboard layout and signals are also different from PC or Mac, which is why early KVM switches could not mix Sun with other platforms (in fact, most still cannot do this).

Around 1995, KVM switches began to appear that could accept Sun keyboard/mouse lines and, in some cases, translate them to PC keyboard/mouse while passing the Sun video through to a high-resolution SVGA monitor. Other KVM switches dealt only with Sun video and keyboards, and did not accommodate PCs. Sun is now shipping computers that still use a proprietary keyboard/mouse connection, but which have conventional HDD-15 SVGA video output (we believe this change began with the Sparc 5 Ultra Enterprise series). This means that a KVM cable meant for one Sun platform may require an adapter to work with a different model. The newer Sun monitors have both 13W3 and HDD-15 connectors so they work with all Sun computers, and with many PCs as well.

SGI Video

Silicon Graphics has specialized in graphics-intensive workstations and servers that are widely used in the motion picture industry and elsewhere. While the company's focus has been changing recently, quite a few of these high-resolution, wide video bandwidth machines are in use and they often benefit from KVM switching or extension. Typically, the SGI machines have separate BNC connectors for Red, Green, Blue and Sync connections, though some may use HDD-15 (VGA-type) connectors. Matching the connector is less of a concern than handling the bandwidth. Often the video output is not only high resolution, but also high refresh rate, so the overall bandwidth can be very high. For example, it is not unusual to see an HDTV (or Cinemascope-like) wide screen format at 1920 x 1200 pixels, running at 85 to 100 Hz. At 85 Hz, this represents a 284 MHz bandwidth. We know of only one manufacturer that makes a KVM switch or extension product to handle this high a bandwidth. Moreover, there can be TWO video outputs per computer, in which case the KVM switch must be able to select and assign two video sources; again, this calls for a special-purpose switch. So while a manufacturer may claim to be

“SGI compatible,” be sure you check the precise specifications of your SGI computer system and of the switch or extension system being considered. [\(SGI keyboards also vary, as described in our detailed technical section\)](#)

NTSC Video

In the United States of America, broadcast television has relied for decades on a video standard defined by the NTSC (National Television Standards Committee). NTSC standard video is an analog signal. TV sets cannot generally be connected directly to computers due to a number of differences in the way they define the video signal. (In the technical section of this document we discuss some of these differences, including [interlaced vs. non-interlaced video frames](#), and other modulation differences.)

Keyboards, Mice, Wheel Mice, Trackballs, Trackpads

Today’s workstation and server keyboards all have roughly the same set of alphabet, punctuation and numeric keys. Keyboards generally have 85 or 101 keys, though there are many exceptions. In any case, you will not find 85 or 101 wires coming out of the keyboard — typically just 5 or 6 wires — because keyboards include a microprocessor that scans the keys to determine which are being held down, and then codes that information into signals which can be defined by an 8 bit serial data stream.

With a few exceptions, most computers use ASCII definitions inside their circuits. ASCII is an acronym for American Standard Code for Information Interchange (pronounced “ass-key”). Keyboards, however, use a concept called “scan codes” which tell the computer which key is being actuated. Each keystroke actually generates two scan codes: one on key-down, the other on key-release. The keyboard BIOS (in PC/AT class machines) or the main BIOS (in PC/XT class machines) translates the scan code pairs into ASCII characters. This lets KVM manufacturers use unusual key sequences, such as “NUMLOCK” + “-” or “CTRL” + “CTRL” or “SHIFT” + “SHIFT” to initiate channel switching or other special functions. Some keyboards have unique features that render them incompatible with certain computers (and incompatible with certain KVMs, too).

Note that the ‘A’ in ASCII is American. Unicode is a newer character coding scheme that has been introduced in recent years. It is designed to support more non-English languages, and you

can expect changes in KVM products to support unicode-based keyboards and operating systems if this scheme becomes popular. If you must accommodate a unicode-based computer or keyboard, be sure to ascertain whether the KVM product under consideration will support it.

While the mouse or trackball (which is simply an upside down mouse that stays in one place) has always been essential to use of the Macintosh operating system, it was not mandatory for PCs, and in fact had no function in the PC’s initial operating system, DOS. Because mice were introduced after the original PCs had been built, mouse capability was initially introduced to PCs via plug-in circuit cards. This third-party approach resulted in three different types of PC mice: the bus mouse, the serial mouse, and the PS/2 mouse. Bus mice are seldom seen today. The Serial mouse was popularized by Microsoft and uses a DB-9 connector just like that of a TTL video circuit, but the connector’s sex avoids any chance of misplugging. The PS/2 mouse, introduced by IBM and now adopted by most PC vendors, uses a mini-DIN 6 connector just like the PS/2 keyboard. Each PC’s operating system (O/S) must be equipped with the appropriate driver software to match the type of mouse in use. If you use a simple adapter to hook up a true PS/2 mouse to a PC with a serial mouse port, it won’t work properly. In fact, serial mice use more wire leads than PS/2 mice. A special class of “combo mouse” labeled “Serial – PS/2” can work in *either* serial or PS/2 mode as determined by sensing the PC hardware to which it is connected (refer to the “mouse” discussion in [“Product Function For The Technically Oriented Reader.”](#)) These mice have a female DB-9 serial connector and an adapter which converts this to PS/2. An ordinary PS/2 mouse will *not* work with a serial adapter.

Most PC mice or trackballs have two or three buttons. Mac mice and trackballs generally have one button, though some have additional special-function buttons (the Mac O/S does not recognize a “right mouse click” as does Windows/Windows NT).

The Trackpad is a technically different means of controlling a cursor but functionally it does the same job as a mouse or trackball. It’s a flat, touch-sensitive pad that may be built into a keyboard or a notebook computer, or it can be in an external housing. Trackpads are available in Mac and PC platforms, and they may require different driver software in a given computer. Not all KVM systems are compatible with trackpads as input devices; it depends on the particular trackpad (or keyboard/



trackpad) code and on the connections.

The Wheel Mouse, which Microsoft developed and dubbed the Intellimouse™, looks like a conventional two-button PC mouse but it has a small control wheel between the two mouse buttons. This wheel directly scrolls windows and performs other functions in savvy Windows™ software. While a wheel mouse uses a PS/2 connector, it requires a special software driver and is not automatically compatible with all software... it is definitely not compatible with all KVM systems. The Intellimouse has subsequently been introduced for the Macintosh product line (with a suitable connector and different driver software); the applications must support wheel mouse input or the unit has no effect. If your computer has wheel mouse drivers or if you want to use a wheel mouse to control one or more KVM controlled computers, be sure the KVM is compatible with the wheel mouse.

SGI (Silicon Graphics) has employed a several different keyboard/mouse standards. In one implementation they employ a standard PS2 connector but it is wired using two pins not used in PC's so that the keyboard and mouse both share a single connector. In other implementations they use conventional PS2 keyboard and PS2 mouse wiring with separate connectors. In still others they have used DB-9 or DB-15 connectors for serial keyboard and mouse I/O ,

Sun workstations use a completely different type of mouse (3-button, and some with optical scanning instead of a rolling ball), and the Sun mice have different connections (8-pin Mini-DIN bussed through the keyboard) and unique driver software.

Sun, Mac and PC mice (or trackballs) are not interchangeable electronically. Even though some manufacturers offer mice or trackballs for the different platforms that differ externally only in their connector configuration, a connector adapter wouldn't necessarily allow a specific model to be used on a different type of computer; format conversion is necessary, too.

Some newer computers have introduced a further complication for KVM systems; the Universal Serial Bus (USB). Compaq, Dell, IBM, Apple, SGI and other leading manufacturers now sell computers that can be controlled by USB-connected keyboards and mice. More manufacturers are joining this trend, abandoning "legacy" ADB, PS2 and AT type connections in favor of more stable, future-looking USB connections. There is absolutely no inherent compatibility between a USB-based keyboard or mouse and a conventional one, so a traditional KVM won't work with these devices. Fortunately, though, many of the USB-equipped computers also have conventional PS/2 (PC) or ADB (Mac) ports that do work with today's KVMs. If not, a variety of USB adapters are available for about \$50 to \$100 each that convert USB to PS/2 or ADB connections and coding (these are 1-way adapters so be sure to get the right one if you need such a unit). Ultimately we will see KVM manufacturers offering USB-equipped switches. This will be beneficial because USB is actually a much better defined standard, and therefore promises greater "universal compatibility" than traditional keyboard and mouse standards.

Serial terminals use several different standards for keyboard coding and connectors. They do not use mice. Teletype machines (TTY) originally used a 5-bit Baudot code, which later evolved into ASCII 7-bit code, which was then picked up by early CRT displays. These were commonly known as "glass teletypes." The ANSI code (American National Standards Institute) defines the character sequences to do things such as switch to high intensity, blink, underline, and position the cursor on a glass teletype. DEC (Digital Equipment Corporation) used a slightly different ASCII code set in the VT-100 terminal series. Subsequent code sets include more escape codes and are designated for use with terminal standards such as VT-220, VG-320, and so forth though all use RS-232 serial protocol.

How Does A Keyboard/Video Switch Work?

Passive Versus Active Switches

The earliest and least complex switches were passive. That is, they had no powered electrical components in them. You would turn a rotary switch, or engage one of several interlocked push-button switches, to connect the attached monitor (and sometimes a keyboard) to the desired computer. This type of switch is still sold (occasionally), and a few have been enhanced to also switch mice. The mechanical switch's chief advantage is low initial cost, but it has a number of offsetting disadvantages, including spiking of video, transients that can blow sensitive circuits, loss of mouse or keyboard sync, and no emulation so that each computer must be booted in sequence (instead of simultaneously) after a maintenance shut-down.

Active KVM switches have powered circuitry that handles the video, keyboard and (in modern designs) the mice.* Depending on the switch design, you either push up/down buttons to step through connected CPUs, you press direct-select pushbuttons, or you place the switch in an auto-scan mode that cycles through the connected CPUs at some preset interval. Many models permit direct selection of the desired CPU by means of keyboard commands and/or a menu system (sometimes known as OSD for On-Screen Display, OSG for On-Screen Graphics, or a similar acronym). While the active KVMS has traditionally cost more than the passive KVMS, the difference has narrowed with the introduction of reasonably designed, inexpensive, active switches from a number of manufacturers. In almost every case, active switches are the superior solution so we do not go into much detail about passive switches in this document.

(*We'll use the word "mouse" or "mice" loosely to mean any cursor-controlling device, which includes trackballs, trackpads, joysticks, and so forth. Just remember that in a given instance, not all such devices may actually be usable.)

With few exceptions, the operating system software and/or the BIOS (basic input/output system) of the PC checks for the presence of a connected keyboard when you first power up (boot) the computer; if no keyboard is connected, you see an error message on the monitor and the system does not start up properly. For this reason, most passive KVMS-switched computers can be booted only when they have been selected on the switch. After a system

shutdown, it will take a long time to start up each computer because someone has to manually switch to each computer, turn it on, etc.

Today's active keyboard/video switches emulate the presence of a keyboard and mouse to all connected CPUs. This means that you can turn on all the computers at the same time, and they will all boot at once rather than sequentially, one at a time. Switches that have such emulation are known as "automatic booting" switches for this reason. They reduce the incidence of hung systems during operation, too, because each computer "thinks" it is connected to a keyboard whether or not you have actually selected the computer with the switch. If you want to read more about emulation, [see the Section on Emulation Services](#).

How Does the Active KVMS Work?

As we have said, the active KVMS emulates the presence of a keyboard to each computer. The originator of keyboard scan codes, IBM, defined three Scan Sets: Scan Set 1 was for the XT computer, Scan Set 2 was for the AT architecture, and Scan Set 3 was for 3270 terminals, which shared the same keyboard layout as PCs. Most clone vendors use Scan Set 2 (AT), whether or not the keyboard has an AT style (5 pin DIN) or PS/2 style (6 pin mini-DIN) connector. IBM and a few other vendors instruct the keyboard to switch from Scan Set 2 on power-up to Scan Set 1, which lets them eliminate the keyboard translator microprocessor on the motherboard. Earlier PS/2s (Model 30 through Mid Model 70) use Scan Set 2, while later PS/2 models (such as Model 80, 85, 90, 95 and 77) use Scan Set 1. Some RS/6000 and Silicon Graphics machines use Scan Set 3. The real issue is whether the KVMS can handle all three scan sets, just like the IBM 101-key keyboard. This requires a suitable microprocessor (or "intelligence") in the switch. Similar considerations apply to mouse operation (serial vs. PS/2 vs. wheel mouse) if the KVM switch is to be widely compatible. Switches that gracefully handle all these emulation modes without errors are said to have Robust Emulation capabilities. The purpose of emulation, simply stated, is to make the computer "think" it is connected to its normal keyboard and mouse, even though it is actually connected to the KVM switch. For more information on emulation, [see Emulation Services](#).

Video is more complex. Some switches merely pass the video straight through, routing the signal from the selected CPU to the connected monitor. However, better switches correctly terminate the video output of non-selected computers to keep the computers' video cards suitably loaded and to avoid spurious signal emissions that might otherwise cause interference (fuzzy, ghost images on screen). A few models allow the user to compensate for color shift or brightness/contrast changes due to cabling or differences in video driver cards. Switches that accommodate XGA-II, Sun, SGI or Macintosh computers have circuitry that returns appropriate information to the computers indicating the size, resolution and color depth of the connected monitor.

Certain highly-capable KVM models also include circuitry to convert between video formats (i.e., Mac or SGI with Sync-on-Green to VGA with Composite Sync), and to convert between various keyboard and mouse coding schemes. This circuitry makes it possible for a single device to offer cross-platform switching capability.

Without special provisions, video cannot travel over long cables because these high-frequency signals become distorted by the reactance of the cables. (Reactance is an electronic characteristic that is present in all cables, and the longer the cable, the more it will degrade a high frequency waveform.) It is possible to reduce the degradation caused by cable reactance by (a) using higher quality controlled-impedance cables, (b) using buffer and booster amplifiers, and/or (c) converting the electrical signals to light and using fiberoptic instead of copper cables. Keyboard and mouse signals are not

as high in frequency as video, yet they still don't travel well over long distances due to timing issues; the capacitive reactance of a cable will slow down the signal, causing a delay in acknowledgment or "handshake," which can cause the link to time-out and produce an error or a frozen system. Mouse coding is sent in packets, and smeared timing in the delivery of these packets can result in misinterpretation of mouse input by the computer.

Some active KVM products, with or without adapters, provide for buffered signal interfaces — that is, they intercept and amplify the signals — making it possible to extend up to several hundred feet the distance between the switch and the computers, or between the switch and the monitor and keyboard. A few products use fiberoptic technology (light transmitted along glass fibers instead of electrical signals in copper cable) to extend the switched distance to thousands of feet; such switches are more expensive. It is possible to add long-distance keyboard/video/mouse extension devices to switches that don't otherwise support long cables ([read about extending the distance in KVM Extenders](#)).

Single and Multi-Console Switches

Many brands and models of active KVM switches (the focus of this paper) are currently marketed. Aside from the issue of single bus or multi-bus control paths, there are differences in physical construction, functional capability, cable interconnect, and methods of control.

Single bus KVM switches provide a single path through which the switching services connect an external monitor keyboard and mouse to any one of the attached computers. Equally, they provide a concurrent input data path for connecting keyboard and mouse signals to the selected output of the port being displayed on your monitor. In all current single-console KVMS implementations, the switch Input/Output (I/O) instructions are hardware resident and require no software to be installed on the switched computers.

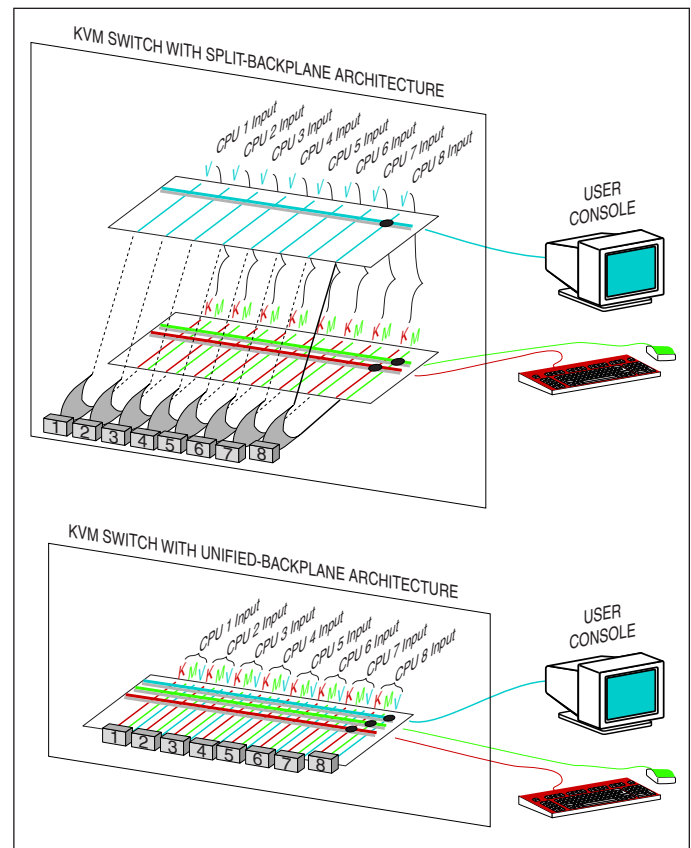
Multi-console KVM switches differ widely in their approaches to routing KVM signals among multiple consoles. [See the specific definitions of switching bus and data paths elsewhere in this document if you have not already done so.](#)

As a refresher, we define a “console” as a keyboard, video monitor and mouse, although in some KVM systems there may be no mouse while in others the console may also include audio (speakers and/or microphone) or even an RS-232 serial terminal or other device. In short the “console port” is one set of connections for a user to control connected computers.

Some multi-console KVMS designs allow the output (video) of a single computer port to be displayed on multiple console monitors simultaneously (concurrent access), while others do not (no switch allows simultaneous keyboard/mouse input from two console ports to one CPU because the computers themselves are not equipped to deal with such input; it is always sequential). Where concurrent access is available, the maximum number of consoles that can access a given computer system ranges from two to sixteen. Remember that this value refers to the number of consoles accessing the same CPU; larger multi-console KVM systems can have many dozens to hundreds of consoles operating simultaneously and accessing different CPUs.

Unified Versus Split Bus Architecture

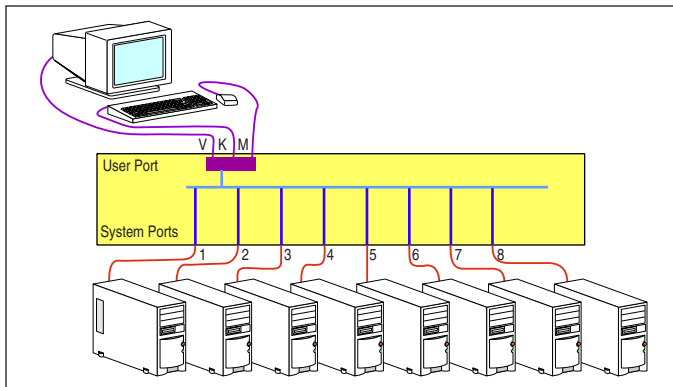
Until recently, most KVM switches routed the video, keyboard and mouse signals along similar, simultaneously-switched pathways. A few of the newer multi console KVM switches depart from this tradition and route video, keyboard and mouse signals separately. In one case, there are actually up to four separate switch chassis, one each for video, keyboard/mouse, serial and audio function; if there are no audio or serial requirements, the respective chassis need not be purchased. In another instance, the matrix-type switch chassis employs a fourteen-layered motherboard (backplane); all connected CPUs apply video signal to that backplane at all times. In this system, the video is routed to user console ports on demand, and a short while later the keyboard and mouse control is assigned to the console port... pending authentication of that user’s administratively-assigned level of access.



Split (top) vs Unified Architecture (bottom) KVMS

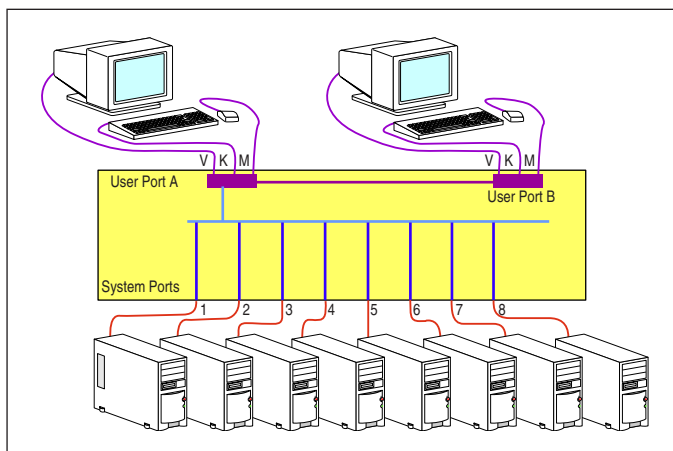
Single Console Versus Multi-Console (and Multi-Access)

Single and multi-console KVM switches serve similar purposes; their unique attributes and capabilities determine which will best serve in a given application. A single console KVM switch provides one console with simple access to one bank of computers (typically numbering 4, 6, 8, 12, or 16). These single-console systems usually allow for connecting multiple chassis (in a daisy-chained or star configuration) whereby the same single console can control as many as 256 computer systems.



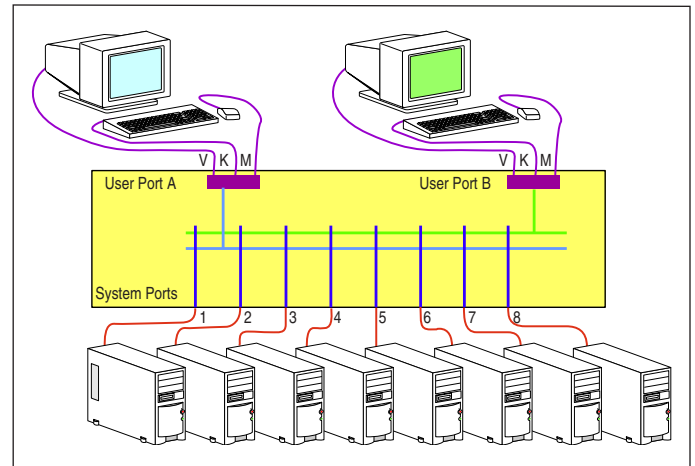
Single-Console KVM Switches of Various Capacities

Adding a limited degree of extra functionality, some KVM switches or add-on external devices create a second console output for the same single-console switch. One should take note of this “Dual Access” is via one shared bus, and does not enable the two user consoles independently select different CPUs as is possible with a true multi-console KVM switch. Instead, the same computer system will be viewed (simultaneously) and can be controlled (alternately) from the two access consoles.



Dual-Access KVM Switch for Two Users is Not True Multi-Console; Both Must View the Same Computer

True multi-console systems enable multiple user consoles to connect either to different CPUs in a single chassis or to CPUs distributed throughout multiple interconnected KVM switch chassis. Multiple consoles typically have access to all computer systems via the backbone “bus structure” of the KVMS system, although some consoles may be restricted only to access portions of the overall system by virtue of their installed location within the switch system.



A Basic Dual-Console KVM Switch in Which Each User Has Independent Access to Any of The Computers

Even if access is potentially available to all CPUs, it may be restricted by an administrator. Other than a handful of smaller (2 to 4 user) multi-console systems, today’s multi-console switches include at least the option for administrator-assigned password-controlled access for each console port. Depending on the user’s profile, login may allow access to an isolated group of computer systems or to all computer systems. It may allow full control of these computers, video-only, or video and keyboard/mouse but no power on/off control (on those few KVM systems optionally equipped to cycle CPU power).

Access control may be implemented by means of on-board security within the KVM system, or it may rely on the security rights from an existing NT server. The handful of recent switches that do rely on NT security represent the first switches in the industry to involve software-based control (as contrasted to firmware-based control). The current minimum software-related integration includes system administration and event logging of user activity on an otherwise hardware-based KVM switch. Other systems now use software for logging in and actual implementation of switching functions. These products probably represent the tip of the iceberg as new implementations are certain to expand the overall functionality of KVM switch systems.

Consider this; if you are in a position to specify the preferred KVM technology for your company, you'll need to identify and survey several variables that affect your Information Technology operations. A small operation or group may greatly benefit from a simple single console switch, yet larger-scale KVM switching — including the possibility of enterprise-wide implementations — may improve the overall productivity of the I.T. department. Consider all pertinent factors when you evaluate a KVM switch system... factors that range from the way hardware is physically deployed to how people work with the hardware. Be sure you understand the large scale KVM solutions, even if they are not your first choice now due to budget or modest requirements. Bear in mind that though you may initially purchase single console switches for small groups, the models and designs you acquire now will have economic significance later when you migrate to a multi-console system; in short, plan ahead.

Single vs Multi-Platform KVM Switches

Many KVM switches support only one type of computer: PC, Mac, Sun, etc. Increasingly, switches are available that support more than one type of computer. Some handle Sun and PC. Some handle Mac and PC. Some handle multiple types of platforms. If you work with more than one type of computing platform and want more information, see the sections on [What If You Have a Mix of PCs and Serial Terminals?](#) and [Platform Support](#) under Multi-Console KVMS Systems - The New Standard

Product Function for the Technically Oriented Reader

You don't have to understand anything about keyboard scan codes, video circuitry, emulation or bus architecture to use a KVMs effectively. On the other hand, if you are designing, specifying or troubleshooting a KVMs, the more you know the better your chances of success. We have written this section of The KVMs White Paper for those of you who are interested in the nitty gritty details of this technology (up to a point... we don't get too involved with the finer points of circuit design). If all the detail that follows whets your appetite for more information, or if you would like to have a live presentation to explain what we've written here, contact the authors of this paper about attending one of our [KVM Technology Seminars](#) or having us schedule one especially for your organization.

Keyboard Switching

The old IBM PC/XT keyboard was a 1-way device. It generated signals that went to the computer. The IBMPC/AT and subsequent platforms used a two-way data path, with the computer probing the keyboard as well as the keyboard sending keystroke data to the computer. To be effective, the active KVMs must emulate the presence of the keyboard to the computer when that computer is not selected on the switch. As indicated previously, not all scan codes are the same, and timing is less than well defined in the so-called standard, so the emulation can be tricky. Store-and-forward technology is used for improved emulation in some switches.

Until recently most PCs used one of two different types of keyboard connectors. IBM's older "PC-AT" style keyboard had a 5-pin round connector which was widely copied. Later, with the PS/2



Original AT-Style or DIN 5 Keyboard Connector

series (circa 1987), IBM changed to a smaller mini-DIN (Deutsche Industrie Normen, a German standards organization) 6-pin round connector. Today, various clone manufacturers use AT or PS/2 style keyboard connectors, and some manufacturers vary the keyboard connector from model to model. A

few models have both types of connectors although the second type may be hidden behind a knock-out in the computer case. Finally, in late 1998 through early 1999, some computer manufacturers began shipping products with USB (universal serial bus) keyboard connections, and only now are KVM makers begin-



USB (Universal Serial Bus) A Type Connector for Keyboard, Mouse and Many Other Interconnections



PS-2 Style or Mini-DIN 6 Keyboard Connector; Same Type Also Used for Mouse

ning to support USB keyboard and mouse. USB to PS2 or ADB (Mac) converters are inexpensive workarounds when there is no direct USB support.

While adapters also can be used to change from AT pin configuration to PS/2 configuration (or vice-versa), there are electronic differences between some computers that are not so easily converted; the so-called key

scan codes may differ, too. The original IBM PC XT keyboard scan set was developed by a student, and was anything but elegant. The subsequent AT keyboard command set was based on the XT, and later IBM developed the PS/2 protocol to differentiate a new generation of computers. Not surprisingly the PS/2 command set relied upon elements of these predecessors. Almost immediately, IBM opened PS/2 protocol for use by other manufacturers but they also ceased development efforts



PS/2 - AT and AT - PS/2 Type Keyboard Adapters



on the PS/2 command set. While the current PS/2 command set has been expanded by a variety of manufacturers on their own initiative, “PS/2” is really not a well defined specification. Nonetheless, a keyboard/video switch that is built to accommodate any PC must be able to handle gracefully historic as well as non-standard, ill-defined variations in keyboard coding. For this reason, you will find some switch models do a better job with certain PCs or keyboards than do others. Sometimes a firmware update in the switch will be required to accommodate some new model of PC, and other switches cannot be updated.

Macintosh computers, except the very earliest models which had RJ-style phone connections, used a separate bus for keyboard signals; the ADB (Apple Desktop Bus) connector is a 4-pin mini DIN. It carries not only keyboard, but also mouse (or trackball) signals. Other accessories can be attached to the ADB as well (including modems, graphic tablets, and software copy-protection “keys” or dongles). As mentioned in the introduction, recent Macintosh Models (iMac, G3 Yosemite, G4, G3 Powerbooks) are shipped with USB connectors, and include USB keyboards and mice. Fortunately, except for the G4, they also have ADB connections for keyboards/mice so they work with conventional Mac or multi-platform KVMs ports. For the G4, use a USB-capable KVM switch or a USB-to-ADB or USB-to-PS2 adaptor.



**Original Macintosh ADB
(Apple Desktop Bus)
Connector Used for
Keyboard and Mouse, as
well as certain other data**

A handful of platforms and keyboards have keyboard control anomalies. AST’s keyboards used IBM’s scan codes, but introduced variations in signal timing and drive capability, which made physical interface tricky. Compaq pioneered autosensing XT/AT keyboard technology. When IBM introduced their 101-key keyboard with autosensing, they did it differently from Compaq. Compaq has not fully implemented the IBM autosensing protocol, but has adopted multiple scan sets. Thus, effective switch emulation of IBM’s and Compaq’s various keyboards can be particularly daunting. At one time, NCR and Leading Edge used the “Keyboard Reset” signal defined only on the old 5-pin DIN connector,

which had to be passed through to the CPU for successful booting; these were XT and early AT computers, now mainly obsolete. Macintosh keyboards use different scan codes, and they are 1-way. The Mac CPU will boot with or without a keyboard, so keyboard emulation is not needed on the Macintosh (though USB models may differ here; we have not thoroughly researched this new interface). Like the Macintosh, the Sun keyboard and mouse share connections via a common bus, although the busses are different and Sun uses different coding and connectors than does Apple.

In addition to consideration of scan codes and connectors, as previously discussed, keyboard power specifications are also an issue. The switch must apply the correct power to the connected keyboard (remember, keyboards contain active circuitry). In some cases, the switch itself is powered by the keyboard output power of connected computers, so there must be compatibility in that specification, too.

Most PCs have 5-volt keyboard power output, typically delivering 0.75 to 1 amp of current. A few KVMs models are powered by the computer’s keyboard output and will not function reliably, or at all, if the computer does not meet the design specification; this is seldom a real problem, though. Some early AT&T and Texas Instruments computers, had 12-volt keyboard circuits with 9-pin D-connectors (TI had one model with a 5-pin DIN that used 12 volts). Some Dell computer keyboards operate at under 5 volts, and some IBM PS/2 models cannot deliver as much as 0.75 amperes (though they are adjustable internally). While most KVMs systems today are not powered by the keyboard power output, at least one model senses the presence of a CPU by virtue of sensing keyboard power presence. And, on the other side of the equation, the Compaq ProLiant 7000 senses keyboard current draw during boot-up, something no prior computer has done our knowledge; a KVM that doesn’t have the correct keyboard input impedance may cause boot errors on this particular computer. A few KVMs systems use the keyboard power output of the CPU only for “emergency” emulation services in the event of a KVM power supply failure.

It can be beneficial if the KVM stores key scan codes and mouse type information about each PC in non-volatile memory. Should power to the switch be interrupted, you would not then have to reboot each CPU in order to restore proper switch operation. Absent this feature, you may want to put the

KVMS on a UPS (Uninterruptible Power Supply). In fact, a UPS for the KVMS is a good idea for the simple reason that UPS power will eventually run out unless there is a backup generator, and if you must shut down the CPUs before the UPS batteries expire, you'll want to have the KVMS working so you can issue the shut-down commands.

As mentioned previously in this document SGI (Silicon Graphics) has employed a several different keyboard/mouse standards. Their 4D series, Indigo, Crimson and Onyx systems use an up-down encoded 101-key keyboard with a bidirectional serial link. Every key has an upcode and downcode, and the keyboard itself has connectors on both right and left side to accommodate a mouse. The physical connection is via a DB-9



Some SGI Keyboards Use DB-9 (Some Use Non-Standard PS/2 and Others Use Ordinary USB Connectors)

9-pin connector, which has separate keyboard transmit and receive data lines as well as a mouse transmit line. Some newer SGI platforms have a mini DIN-6 keyboard connector on the CPU board, but it is wired to handle keyboard transmit and receive as well as mouse transmit, unlike PS-2 standard systems where the same physical connector is duplicated, one for mouse and another for keyboard. A number of SGI systems also utilize serial connections for graphics tablet input, and these may be via DB-9 or mini DIN-8 connectors.

Ultimately, while robust emulation is a valuable asset for a KVMS, there may not be a way for your switch to comply with certain non-standard keyboards (or mice/trackballs/other pointers).

Mouse Switching

We have already discussed the bus mouse, serial mouse, PS/2 mouse, Sun mouse and Mac mouse. Each uses a different connector and driver. Switches that do accommodate mice must emulate the mouse back to the computer even when a given CPU is not being addressed in order to avoid operating system or applications failure. (It is true that Macs do not require mouse emulation, and PCs can operate with keyboard commands replacing many mouse movements, but if the O/S calls for a mouse, you'll want to have one that's usable). The KVMS may be

designed to allow more than one type of mouse to be connected to it, with internal circuitry to convert control protocol from a given mouse to properly drive a variety of connected computers which may be using different mouse drivers.

Some KVMS systems employ one microprocessor for the keyboard and another for the mouse, while some use a single microprocessor for both functions. Its interesting to note that the 8042 keyboard controller used in today's computers is the same chip used in early PCs. This chip is a dual-channel device and the second channel can be used for control of the mouse.

Each approach has its pros and cons. Dual microprocessors can create problems if the microprocessors do not switch in perfect synchronization as the user selects various computers. KVMSs with a single microprocessor for both keyboard and mouse may rely upon that microprocessor to control multiple switching channels (i.e., four to eight computers). This avoids synchronization problems, but may cause delays if the microprocessor cannot keep up with the demands of the multiple mouse and keyboard emulated ports. Several manufacturers now use a single microprocessor per channel (per switched computer) in an effort to avert synchronization and throughput problems. This approach tends to be more expensive and is therefore found in switches costing a bit more. The point is ... not all switches are created equally, and you need to evaluate how their design will affect their performance in your application.

History of the Mouse

The Mouse has evolved from a research device at the Xerox' PARC facility in Palo Alto CA in the 1970s to a commercial product of very limited distribution in Xerox' STAR word processing/page layout system around 1979 or 1980, then to wider use in Apple's Lisa and its successor the Macintosh. Later, and of course it later became a standard in the earliest versions of Microsoft Windows.

In a manner that would have pleased Charles Darwin, the mouse has evolved ever since its inception. It is not our purpose in this document to detail obsolete devices. One of these, while it still exists, is the Bus Mouse, which was an early implementation for PCs. The bus mouse had only motion sensing built in, and it relied on an ISA card in the computer to interpreted that motion. Connection was via a 9-pin Hosiden connector, not the DB-9 connector used in subsequent Serial mice. While



DB-9 Female Connector on a Serial Mouse KVM Cable

a few Bus Mice may still be in use, only one KVM switch manufacturer supports the Bus Mouse, so we're not going to discuss this now obscure technology any further.

The Serial Mouse came next and is still common. It relies on active electronics that internally code mouse motion and communicates it to the CPU via a serial protocol to a serial port. The Serial Mouse uses DTR and RTS lines to bring +5V power into the mouse for powering its microprocessor. The original serial protocol supported two action buttons. Logitech extended the protocol to support a third button, and a few other manufacturers created their own protocol extensions. On the Microsoft serial mouse, the protocol utilizes 3 bytes whereas Logitech's serial mice use 5 bytes, the additional bytes being active only when the middle mouse button is activated. These differences help explain why many mice are sold with proprietary software drivers... they contain the extensions for special functions that are not included in the computers' basic software. Of course, KVM switch manufacturers have to be able to deal with this wide variety of extensions without the benefit of being able to load up the drivers because switches have traditionally been built to work externally to and independently of the connected computers. Clearly a KVM switch designed only for a pure 2-button mouse wouldn't behave well with a Logitech 3-button mouse; in fact, they usually lock up or work intermittently. Eventually, most KVM manufacturers figured out how to deal with more popular non-standard mice, but this example illustrates why so-called standards aren't sufficient to ensure that a KVM will simply work no matter where it is used. Serial Mouse communication is one-way from mouse to computer. This point is significant as you will soon learn.



PS-2 Keyboard and Mouse Connectors are Identical Mini-DIN 6 Type

Personal System 2 computer (PS/2). PS/2 mice incorporate two-way communication using 3-byte data packets. The first packet defines button state (up or down), and the subsequent packets define mouse movement (X, Y). The mouse sends synchronous serial data similar to the protocol used by a PS/2 keyboard; in fact, the data is handled by the second channel of the keyboard controller.

It is significant to note that only the movement relative to the prior mouse position



PS2-Serial Mouse Adaptor is Only Usable With Special Combo Mice; Many Adaptors Work Differently

is sent, not an absolute pixel map location. That's why a mouse can become unsynchronized if there is any interruption of its data stream to the computer.

An unsynchronized mouse, with a KVM switch, is manifested as a cursor that appears to jump and move around wildly, stimulated by but not responding sensibly to mouse movement. Some KVM manufacturers do a better job than others of avoiding this condition, or allowing the user to fix it quickly when it occurs.

Combo mice have a male 6-pin Mini DIN (PS/2 style) connector and a cable adapter that can convert it to a female DB-9 (serial). Internally the mouse sets itself to transmit serial data or synchronous (PS2) data; the PC hardware determines the mode of mouse operation.



Microsoft Intellimouse™ Beside Logitech's Wireless Wheel Mouse (left)

All currently shipping PC-type KVM switches require the use of a PS/2 type keyboard and mouse, though most also support computers with serial mouse connections and AT keyboard connectors. The reason for this is that the PS/2 mouse is capable of the 2-way communication that the PS/2 computer's mouse port requires but will also fall back to 1-way communication when translated to serial protocol. The inverse is not possible.

The PS/2 mouse is so named because it was developed by IBM with the introduction of their

A newer variation of the PS/2 mouse is the Wheel Mouse. Whereas a traditional PS/2 mouse uses 3-byte data packets of 8 bits per byte, the newer wheel mice use 4- or 5-byte data packets. (Microsoft's Intellimouse™ uses 4 byte coding and some of Logitech's Wheel Mice use 5 byte coding with the extra byte used for a proprietary extension to support a third mouse button.) Not all KVM manufacturers have changed their firmware to support these newer mouse protocols. In addition to the protocol changes, the wheel mice use different wiring within the cables so that while the connectors appear to be the same, they don't necessarily work the same.

Trackballs, while they perform the same function as mice, sometimes use proprietary drivers which are not necessarily supported by a given model of switch.

USB Connections

The Universal Serial bus is relatively new. It is a medium-speed serial bus that permits connection of a large number of external devices to a computer, with hot-plug on-the-fly device changes and auto-recognition. Computers that support USB connections generally allow for USB-type keyboards and mice but may also be connected via USB to a compatible printer, video or storage media (CD drive, etc.). The type of devices that can be supported are determined by the USB specification and, within a given computer, by its own USB support database. USB is not well suited for hard drives because the bus is not fast enough to handle the data transfer rates of today's hard drives.

The USB (Universal Serial Bus) keyboard or mouse is not yet supported by more than a few small-scale KVMs, though this may change in the future so ask us or the KVM manufacturer if you have USB keyboards that must be accommodated. Don't confuse a "bus mouse" with a "universal serial bus mouse." The Bus mouse, as explained previously, was an older standard something like a serial mouse but it interfaced to a PC using a dedicated interface card. The USB mouse uses one of two standard USB connectors that have no "pins" but rather a mating slot with multiple conductive fingers.

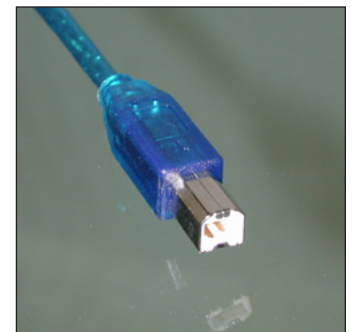
The current USB 1.1 standard is about to be superseded by 2.0. Within USB 1.1, there are actually two standard connectors, A and B. The slot-shaped A-standard is used for patching connections; it may be located on a chassis or in-line between

two cables. It has a male plug that measures 4.5 mm thick x 12 mm wide (0.17" x 0.47") that goes into a receptacle measuring about 8 mm x 16 mm externally (0.31" x .63"). The nearly square B-standard is for use with devices that have detachable cables; the B plug measures 8.0 mm wide x 7.26 mm high (.31" x .29") and goes into a receptacle measuring about 11.5 mm x 10.5 mm externally (.45" x .41"). B connections are only made on a chassis, not for in-line extension. Both the A- and B-standard USB connections utilize four internal conductors plus a shielded jacket.

Without going into detail about the USB protocol for mouse (or keyboard) at this time, it does represent the first time that a true, well-defined, platform-independent standard is being promulgated and adopted throughout the computer industry. At the time of this writing, a few small KVM switches have USB capability, but none of the larger. However, off-the-shelf USB-to-PS/2 and USB-to-ADB adapters are available for \$50 to \$100 each and they allow USB-type devices to be integrated into traditional KVM switches. Eventually we expect to see larger USB-capable KVM switches that do away with the need for adapters. However, the implementation is not as simple as it would seem due to the way USB works and the way USB databases are built by each USB-equipped computer or hub. [**<USB 1.1 spec.>**](#)



USB A-Type Connector



USB B-Type Connector

What it Takes to Deliver a Good KVM Switch

Today almost any company can put a KVM switch on the market within a few months. That's because generic chips and circuit boards are available from original equipment manufacturers to perform the basic switching functions, or in fact all of them. However, all the many variations in keyboard and mouse and, to a lesser degree, video standards are quite difficult to accommodate in a single prod-

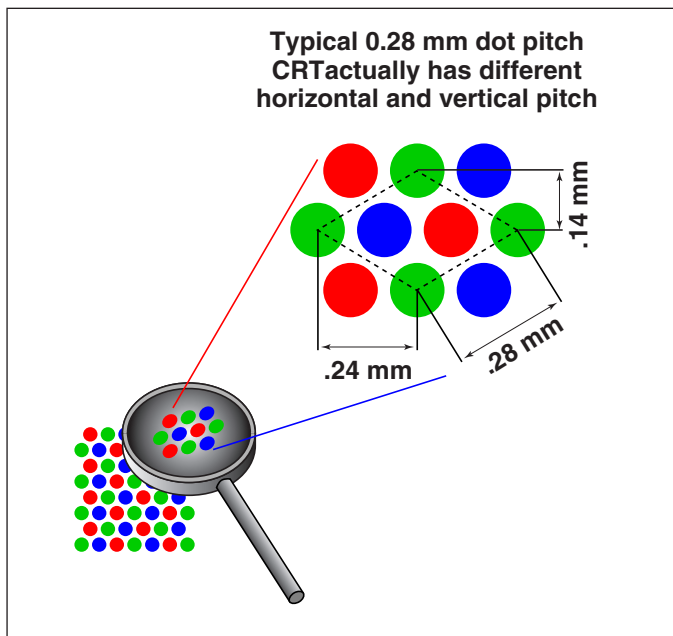
uct. The more experienced manufacturers deliver KVM switches with robust emulation services. They have had the benefit of the finances, staff and other resources to acquire and evaluate the many different computers and peripherals. Issues of timing and waveform and poorly defined “specs” cannot be resolved by web searches and data sheets alone... they require hands on testing and documentation. Better KVM switches incorporate custom programmed firmware that is periodically upgraded (and is ideally field upgradeable) to remain compatible with current devices and operating systems. This is why one must be wary of any switch not being offered by an established, primary KVM manufacturer. Anyone can put a label on a box, and many do, but few can back that product with the design expertise and technical support that you should demand from a device that can bring your server farm to a standstill if it doesn’t work properly.

A Video Refresher

Before you can truly understand the way KVM products handle video, you must understand the types of video that are found in today's computing environment. Using the KVM is a lot easier, but you're reading this section because you want to know more than the average user.

Color Depth

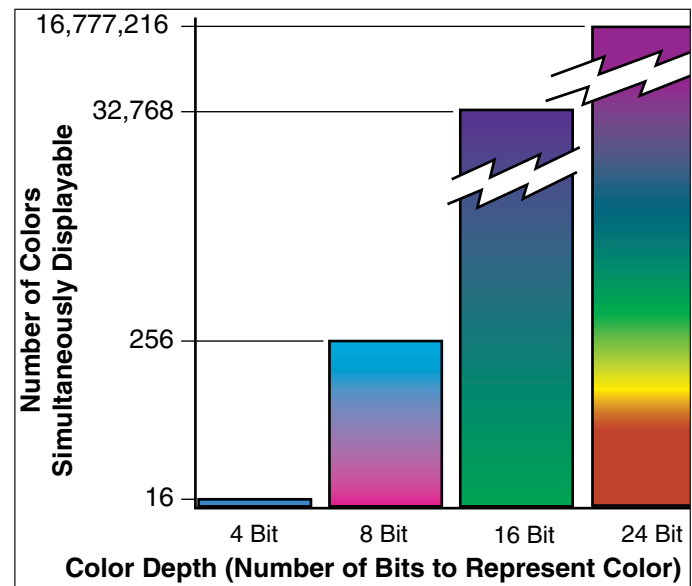
A monochrome monitor is not a 1 bit display; the screen can be off, on, or high-intensity for a given pixel. When the electron beam in the CRT (cathode ray tube) turns on, the phosphor color of a typical monochrome display will be white, green or amber. One variation is the gray-scale monitor. Gray scale monitors use 2, 4 or 8 bits of data to define 4, 64 or 256 levels of intensity for each monochrome pixel — not just on/off.



All Color Monitors Use Red Green and Blue Phosphors; Higher Resolution Models Have Smaller Dots That Are Spaced More Closely AND They Have Electronics To Handle Higher Bandwidth Signals

Today, you may find color displays that use 4-bit, 8-bit, 16-bit or 24-bit data words to define, respectively, 16, 256, 32,000 or 16.7 million colors. 32-bit color display cards are available, but they actually use 24-bits to define the displayed color and the remaining 8 bits for other functions (overlays, transparency, cut/paste channels, etc.). Color monitors utilize three different phosphor dots (red, green and blue) to define a single pixel. Each phosphor

can be illuminated to varying degrees of intensity, depending on the available color depth of the display card driving the monitor. In a 256 color display, colors are defined by color tables, and each entry has three six-bit color fields. Thus, the scale of possible colors is $64 \times 64 \times 64$, or 262,144 possible colors, but only 256 at any one time. These 256-color subsets are sometimes called color palettes.



The Number of Colors Displayed Depend on The Video Driver Card and The Software, Not The Monitor

A 16.7 million color display uses an 8-bit intensity signal to define 256 levels of brightness for each of three colors (red/green/blue); mixing the three color's $256 \times 256 \times 256$ levels of intensity produces 16.7 million colors, so palettes are not necessary. You will sometimes find 32-bit color software used for 8-bit representations of 4-color CMYK (Cyan-Magenta-Yellow-black) ink-on-paper printing, but the monitor is inherently a 3-color device, where black is the absence of any color, so it needs a maximum of 24 bits, not 32.

Sync

While SYNC (synchronization) frequency is directly proportional to refresh rate, it is not the same thing. Typical vertical sync frequencies vary from 57 Hz (Hertz, or cycles per second) to 100 Hz. The frame rate, or refresh rate, equals the vertical sync frequency in a non-interlaced monitor (which is what most computers use). For an inter-

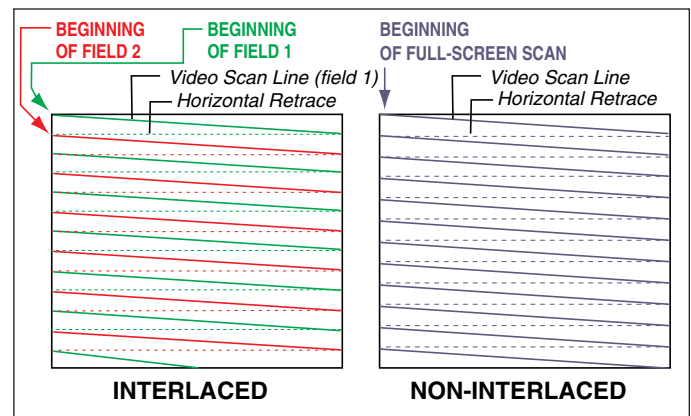
laced monitor (more typical of a television set), frame or refresh rate is half the vertical sync frequency. For example, 70 Hz interlaced paints a new screen 35 times per second. The non-interlaced video requires significantly higher bandwidth. Anything above 75 Hz for the monitor's prime resolution setting is considered VESA standard - a rating system that enables a monitor vendor to use the "flicker-free" logo. The refresh rates decline at higher resolutions because the number of pixels the monitor must refresh increases, slowing down the refresh speed.

The horizontal sync frequency is measured in kiloHertz (kHz, or thousands of Hertz). It is derived by multiplying the vertical sync frequency (refresh rate in non-interlaced mode or 2 x refresh rate in interlaced mode) by the number of horizontal lines. In other words, the sync frequency also increases with greater numbers of pixels displayed. The typical horizontal sync frequency for a 14-inch VGA monitor is about 31.5 kHz, though very high resolution monitors can have sync frequencies upwards of 100 kHz. The *video bandwidth*, however, is... about 28 MHz on the 14-inch monitor.

Video bandwidth is calculated using the sync frequency, interlace and the number of pixels displayed, as well as the *blanking interval*, or dead space between images. Video bandwidth is equal to: $(H \text{ pixels} \times V \text{ pixels} \div \text{Interlace factor}) \times \text{Vertical sync rate}$. For typical VGA, uncorrected Video Bandwidth = $(640 \times 480 \div 1) \times 60 = 18.4 \text{ MHz}$. If you take the total time available for a horizontal scan line and the corresponding retrace, and divide this by the actual time used to display pixels, you get a factor of 1.45; when multiplied by 18.4, this yields 26.7 MHz. Similarly, the wasted time in vertical retrace yields a factor of 1.03, resulting in 27.5 MHz actual video bandwidth. Today, though, 17-inch monitors are the most common size in the data center and office environment, and you'll often see these monitors set as high as 1024 x 768 pixel resolution. A monitor in this display mode, with an acceptably low-flicker 75 Hz refresh rate, will have a video bandwidth of $(1024 \times 768 \times 1.45 \times 1.03) \times 75 = 88 \text{ MHz}$. Higher resolution images used in graphics and video effects work often run on larger monitors at 1600 x 1200 pixel resolution at 75 Hz to 100 Hz, in which case the bandwidth requirements can exceed 250 MHz! Few KVMS systems can accommodate bandwidth as high as even 150 MHz, so if you are switching in a graphics-intensive environment, check the KVMS video speci-

fications carefully. See the full-page illustration of Resolution vs. Bandwidth which follows.

Interlaced monitors (monitors with a lower refresh rate) will flicker more; you may notice this if you move your eyes quickly, chew gum while viewing the screen or view from a distance. The larger the screen (or at least the higher the resolution), the higher the actual horizontal sync frequency for a given refresh rate. Rapid refresh rates (for stable, low-flicker images) and large, high resolution images require ever more video bandwidth, which requires faster more costly circuitry and higher-quality controlled-impedance cabling. This is why a given switch that works acceptably with VGA may degrade an SVGA or an XGA image.

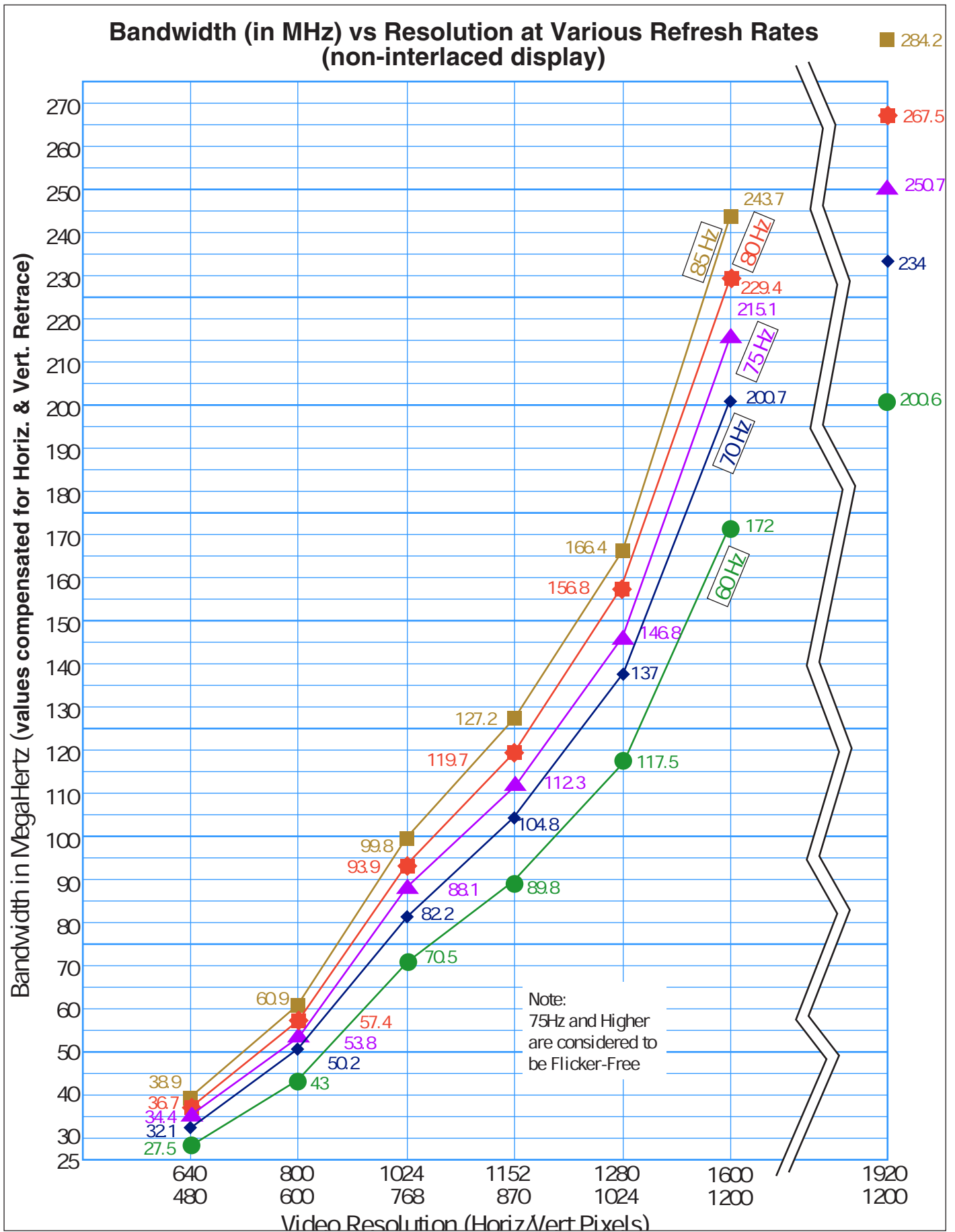


Interlaced Video (left) is Most Often used for Television, Whereas Non-Interlaced Video is Generally for Computers

KVMS Video Signal Processing

A KVMS made strictly for PC switching should provide video buffering for more stable on-screen images and longer video card life. The signal enters the KVMS after emerging from the various computer display card outputs. Ideally, the KVMS buffers and terminates the video signals, then passes signal from the selected computer to the monitor. Technically, this is merely amplification, not signal processing.

When mixing computer platforms, the KVMS may not only buffer the video, it may also translate the signals from the various computers to work with a single monitor. Mac and Sun platforms may have vertical and horizontal sync frequencies that differ from PCs. In some cases, a multi-sync monitor can handle conversion between video sync frequencies, though there are other aspects to the conversion that may still have to be handled by the KVMS (video sense data, for example).



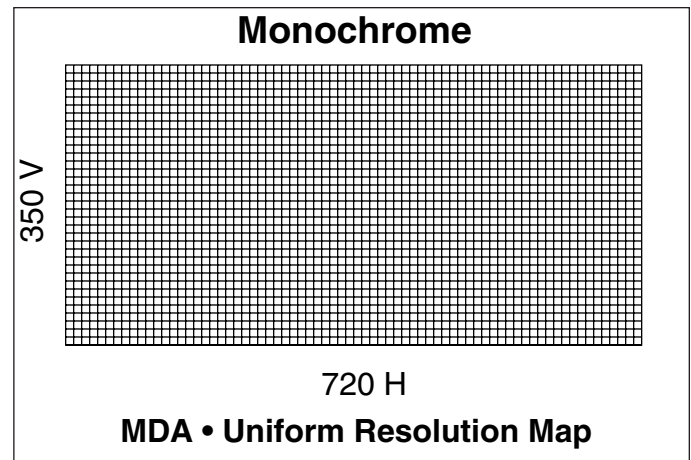
Aside from different sync frequencies, some computers (Sun, Mac) require information about the monitor size (or resolution) and even the color depth be returned to the operating system. Inexpensive mechanical adapters are available to connect in-line with traditional Mac video circuitry and which provide jumpers, rotary or DIP (Dual In-line Package) switches. These let the user set the (10 data bit) screen resolution data that returns to the connected Mac.

Even though resolution data may be returned to the computers by the KVMS, not all KVMS products are capable of displaying all resolutions. Resolution capability is dictated by both the bandwidth capability of the KVMS (and its cables), and by the KVMS's firmware (code written to one or more integrated microprocessors in the switch). While most KVMSs support higher resolution VGA, SVGA and XGA directly, some require external hardware and usually the use of a high-quality multi-sync monitor in order to provide a crisp display at high resolution. Sun monitors, while offering high resolution, until recently could not be used on anything but Sun platforms because they operated at a fixed frequency atypical of PC or Mac monitors; the latest Sun monitors are multi-sync, though you need to check the particular model monitor; multisync models will have both the traditional 13W3 Sun video connector and an HDD-15 VGA-style connector.

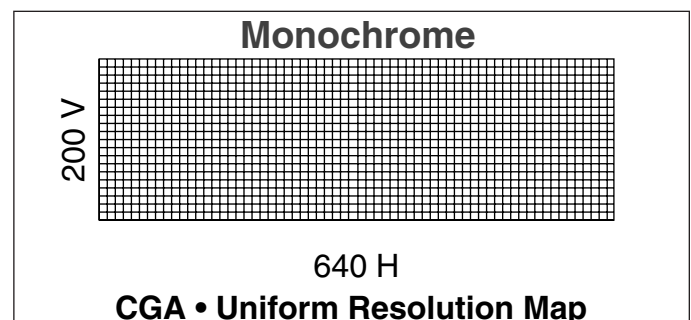
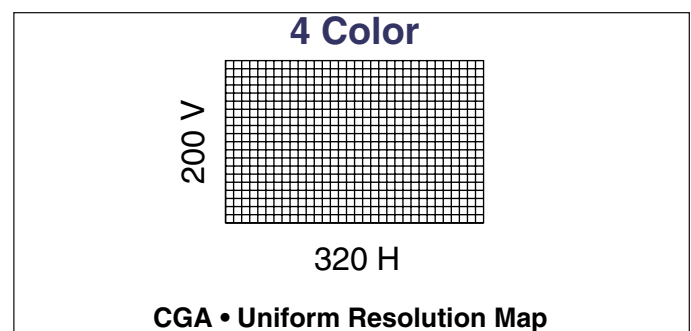
Some manufacturers of active KVMSs utilize integrated circuits to process the video. If the ICs are not of high quality, and do not utilize sufficiently high bipolar power supply voltage, the ICs can impose bandwidth limitations and cause video distortion (you see this as smearing, ghosting or a general lack of clarity). Typical 5 Volt PC power supplies do not yield exceptionally good results with ICs. At least one manufacturer uses discrete transistors in the video circuit, which, with good video amp design and ample adjusting points, provide the extended bandwidth necessary for low video distortion. Higher supply voltages or high-speed ICs can alleviate video quality problems, though proper grounding and shielding are equally important issues that are not always handled properly. Published specs just don't tell the whole story with respect to video quality so get a demonstration, recommendation from a trusted and knowledgeable party, or a return/substitute guarantee from your dealer.

Monitor Types & Standards

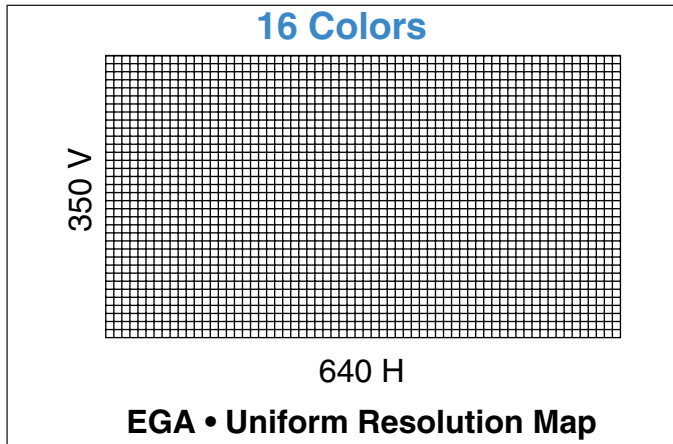
First there was TTL (Transistor-Transistor Logic). The original PC video signal was capable of limited resolution. The MDA (Monochrome Digital Adapter) provided single-color display at a resolution of 720 H (horizontal) by 350 V (vertical) pixels. Typically, you would see white or green type against a black background. European research indicated that amber was less fatiguing, so soon yellow-on-black monitors appeared. All used the same MDA card, just different phosphors in the CRT.



The CGA (Color Graphics Adapter) card gave us up to four colors displayed at a resolution of 320 H x 200 V, or it could be switched to operate in single-color mode at 640 H x 200 V pixels. Thus, you could sacrifice color depth in favor of resolution where that was desirable (i.e., for text display).

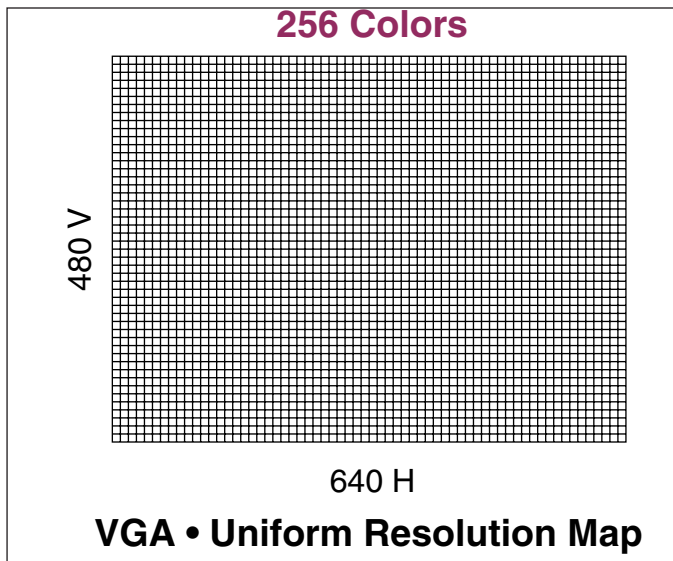


The EGA (Extended Graphics Adapter) card increased the color depth and resolution. You could have 16 colors displayed at a resolution of 640 H x 350 V pixels. By today's standards, neither CGA nor EGA is impressive, but they were adequate for text and primitive graphic display.



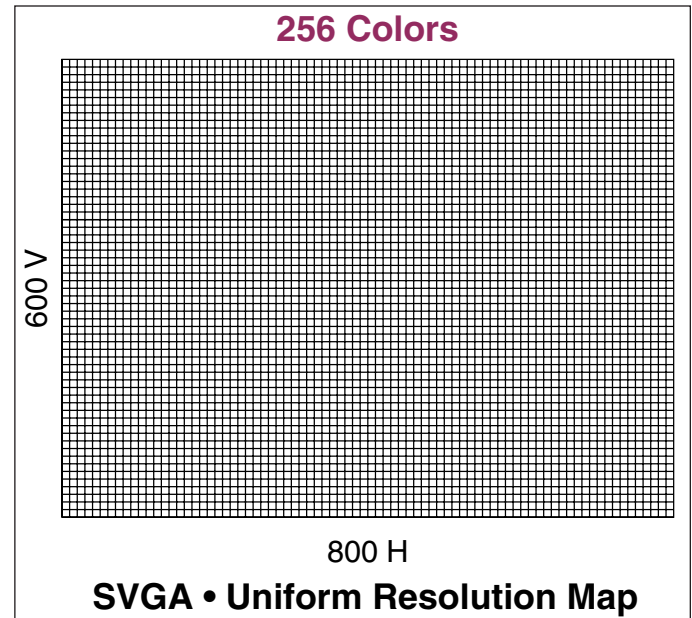
Because TTL video uses modest amounts of RAM (random access memory), a few servers were equipped with these cards long after VGA became the norm elsewhere. Today RAM is so inexpensive that there is no reason to stay with TTL video, and you just don't find it in recently designed computer equipment.

IBM introduced the VGA (Versatile Graphics Adapter) standard in 1987 when it rolled out the PS/2 family. VGA, using analog monitor technology, is capable of displaying up to 256 colors simultaneously with a resolution of 640 H x 480 V pixels. VGA preserves about the same aspect ratio as EGA, but with 16 times the number of colors. VGA uses

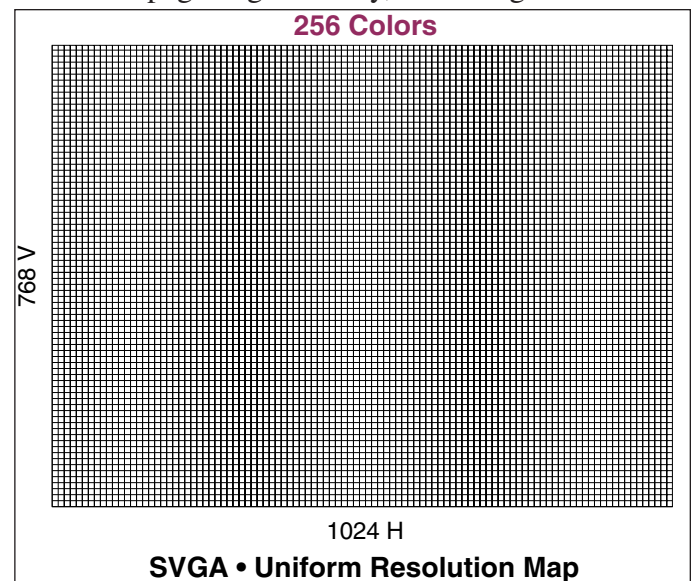


a zero to 700 mV signal in discrete steps; the more colors, the smaller the steps. For example, 256 color

mode is 8/3 bits per color, or about 100 mV per step. The super-fidelity cards of 16.7 million colors based on a 24 bit color field (8 bits per color) have 256 steps of approximately 3 mV per step per each of three phosphor colors. Third party vendors pushed VGA to higher limits, with SVGA modes of 800 H x 600 V pixels or 1024 H x 768 V pixels. Both modes provided graphic designers and CAD



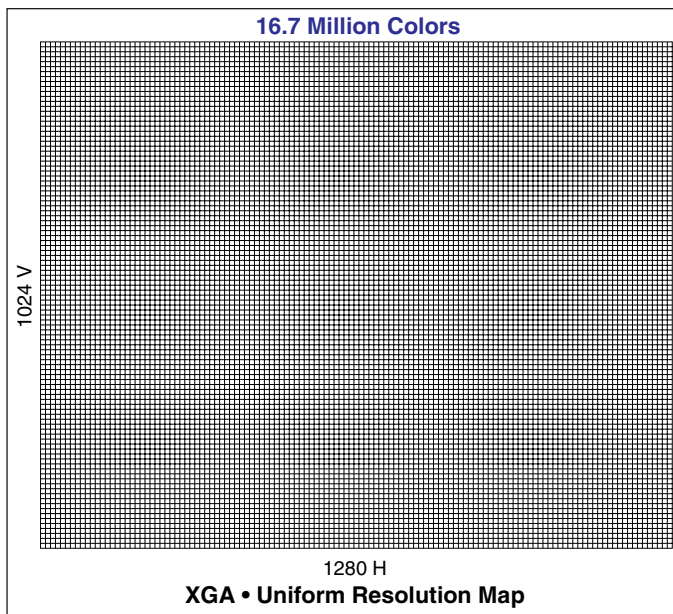
users with fine lines and well-formed type, allowing them to work long hours on complex images with less visual fatigue. The 1024 H x 768 V pixel display on a 19 to 21 inch diagonal monitor affords the opportunity to view a 2-page (11 x 17 inch) page layout at full size WYSIWYG (What You See Is What You Get) minus about a half inch border; at slightly reduced image size, you can view out to the page edges. Today, these large monitors



and high resolutions are commonly used in work-a-day situations where users wish to display multiple, partially-overlapping or completely unblocked windows for one or more applications.

Some designers, multimedia producers, and CAD operators required still higher resolution, and IBM introduced 8514/A video, which had a 1024 H x 768 V resolution in interlaced mode, as well as VGA compatibility. This approach had flicker problems, and has been largely abandoned in favor of the subsequent XGA standard, which is capable of color depths to 16.7 million simultaneously displayed hues (i.e., virtually continuous display of the full color spectrum without banding), and optional resolutions of up to 1280 H x 1024 V pixels. Because a given monitor might not be capable of displaying such high resolution images, or since high res mode might not be desirable if the screen size were small, XGA-II video monitors include signal wires that “tell” the display card about the type of monitor in use so the card can generate appropriate images.

Even the best conventional 19” to 21” (diagonal



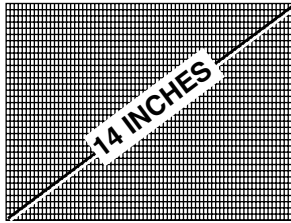
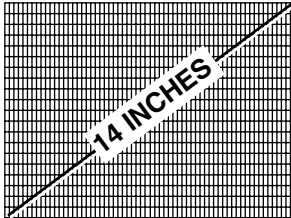
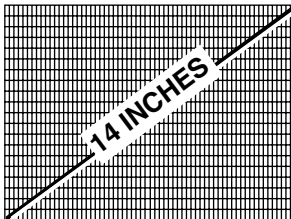
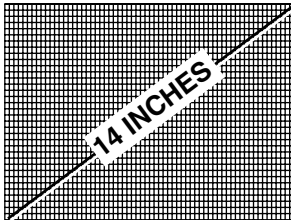
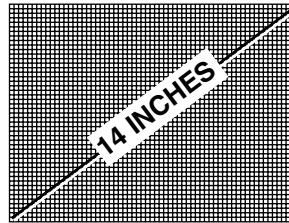
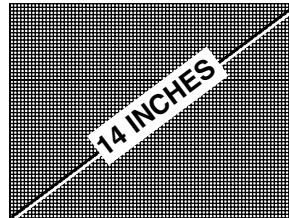
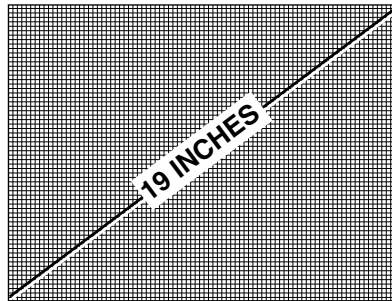
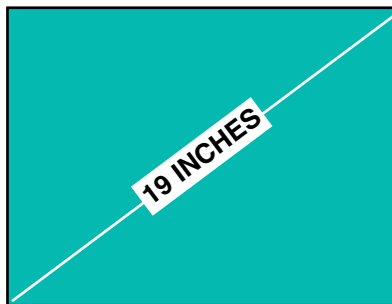
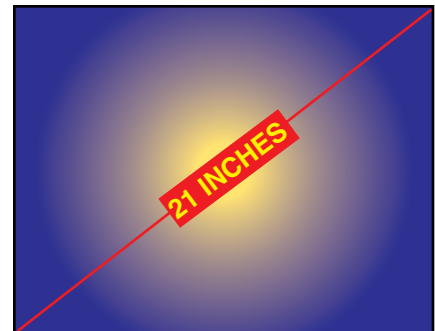
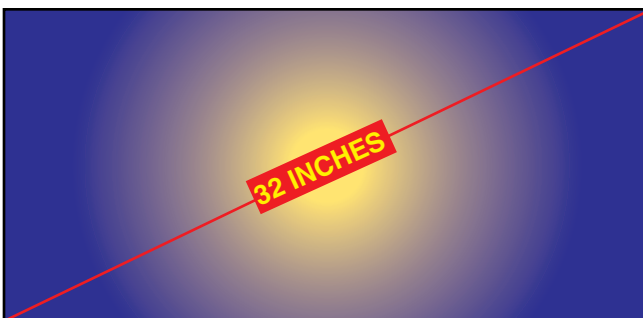
measured) CRT monitors cannot display much better than 1600 x 1280 resolution due to electromechanical limitations in the technology. There are now quite a few video driver cards that support 1600 x 1280 or 1600 x 1200 resolution, though this high density is generally used only for specialized graphics and video production/effects work. A few new monitors are very much wider than they are tall (the HDTV or High-Definition Television format has pushed this along), and they may go to 1920 x 1200 resolution, though pixel sharpness is hard

to preserve near the outer reaches of the screen. It takes a special video card to be able to drive such wide monitors, and these cards are now marketed. Existing KVM systems generally were not designed for the kind of bandwidth necessary to transfer this exceptionally high resolution video, though a few special-purpose KVM switches can handle it.

VESA (Video Electronics Standards Association) DDC (Display Data Channel) video cards are built to support a different video standard even though the connectors used are the same as VGA. VGA only needs 10 of the 15 pins in its HDD-15 connector. VESA-DDC uses the additional conductors and pins to convey the DDC serial data, data clock, a reserved line, and 5V power. If your computer uses a VESA video adapter, it probably will NOT be compatible with a KVM switch, even though you can usually plug it in.

As we outlined earlier, Macintosh models that support external video do it either through video circuitry built into the motherboard, or via plug-in display cards. Mac video is analog. Those Macs which use motherboard-based video differ in the maximum resolution and color depth, and often both can be increased by plugging in additional video RAM. Currently, the maximum onboard video capability of Macs is as high as 16.7 million colors and as high as 1152 H x 870 V pixels, though there may be a trade-off of color depth for resolution due to video RAM limitations. Plug-in display cards are available with resolutions up to 1280 H x 1024 V pixels (a few cards offer extremely high resolution of about 1664 H or even 1900 H pixels x 1280 V) at color depths to 16.7 million. The refresh rate of Mac monitors is not fixed either, but it is generally about 72 or 75 Hz, and occasionally up to 100 Hz on better video card/monitor combinations. The method of sync was also different from PC monitors on early Macs; Early Mac video color cards superimposed the sync pulse on the green video signal. To further complicate matters, most Power PC Mac models are capable of connection to VGA monitors, either directly or with the addition of an inexpensive (approximately \$15) in-line adapter.

In order to mix traditional Mac video with PC video in a given KVM, and to drive a shared VGA monitor, it is necessary to strip the sync from the “green” Mac video line, then regenerate it for proper feed to the VGA monitor’s sync line. As we mentioned previously, the KVM (or an adapter) must also return a code to the Mac indicating the resolution and color depth of the connected monitor.

**Digital Signal,
Monochrome****MDA**720H x 350V
(1 Color)**CGA**640H x 200V
(1-Color Mode)**CGA**320H x 200V
(4-Color Mode)**EGA**640H x 350V
(256 Colors)**Analog Signal, Color
(or Gray Scale)****VGA**640H x 480V
(256 Colors)**SVGA**800H x 600V
(256 Colors)**SVGA**1024H x 768V
or
1280H x 1024V
(256 Colors)**XGA-II**1280H x 1024V
(16.7 Million
Colors)**Newer format color images - Either extended VGA-type analog
or new type digital (USB or other digital format)****Ultra-High Res**(HDTV-Ready)
1920H x 1200V
(16.7 Million Colors)Note: Conventional NTSC
television has a 3:4 (1.33)
aspect ratio, whereas HDTV
has a 9:15 (1.78) aspect ratio.**Very High Res**1600 H x 1280V
(16.7 Million Colors)

This Summary of Common Video Resolution and Color Depth Specifications is Not All Inclusive

NTSC Video is Not Optimum for Computers

NTSC (National Television Standards Committee) video is analog, as is VGA, but that's about the only similarity. The frame rate is just under 30 Hz; that is, there are about 30 full images per second being displayed. However, because each TV style image is drawn by two sequential scans of the screen, one beginning in a corner of the screen and the other beginning in the middle of the screen, the effective refresh rate per scan is about 60 Hz ([see the illustration of interlaced vs. non-interlaced video scans](#)). Phosphor persistence (the amount of time it glows after being hit by the electron gun) plus human perception merges the two low-resolution scans into a single higher-resolution full-screen image. This kind of TV display is known as "interlaced" video. Interlaced fields are intended to reduce video bandwidth, but because an entire screen is produced at half the Vertical Sync rate, this causes flicker. Interlacing, in itself, does not cause reduced sharpness, but the monitors that rely on interlacing to get higher resolution are usually cheaper and inherently less sharp than more expensive, non-interlaced monitors. Computer video is increasingly non-interlaced (interlaced technology is dying despite a large installed base); non-interlaced means each scan is a whole frame that sweeps the entire screen with the entire video image, not two fields per frame with half the image information. To connect a computer to a TV, circuitry is needed to convert the video to interlaced images at the correct vertical sync frequency. Typically a loss of resolution and a degree of jitter or aliasing occurs with this conversion; image degradation is particularly noticeable when displaying text or line drawings.

With the exception of a few TV sets that have "monitor" capability (defined as separate R/G/B or red/green/blue and sync inputs), the TV is meant

to receive an ultra-high-frequency phase-modulated broadcast signal that contains the video and audio information. Thus, in order to connect a computer to a TV set, as opposed to a TV monitor, a modulator is also required. The modulator typically converts RGB video to TV channel 3 or 4 frequency signals that are subsequently treated by the TV receiver just like a normal broadcast station's signal.

Full-size, full-motion NTSC broadcast Television images require 4 MHz to 6 MHz of bandwidth (MHz is a Mega Hertz, or one million cycles per second). A 90 MHz Pentium-equipped computer will require almost all its processor power to handle full-motion broadcast video with audio, and video production or effects work on a computer demands a much more capable processor. (TV sets don't have to have such processing power because they typically handle the signal in the analog domain, not as a digitized data stream.) However, broadcast video demands are slight in comparison to a high-resolution computer monitor displaying 1024 x 768 pixels at 72 Hz vertical sync rate. That monitor is displaying 56 million pixels for each of 3 colors. This requires a video bandwidth of 70 MHz (the dot rate for a single color) *unmodulated* — a lot of processing power for any computer workstation. And if you are using 16.7 million colors, that eats up memory, too. All this explains why TV sets are not generally used for computer display, nor can the TV tuner be used as a video switch (just in case the thought occurred to you).

One more potential TV/Computer video incompatibility is signal level. VGA levels are zero to 700 mV (0.7 volts) whereas NTSC is zero to 1000 mV (1 volt).

Other KVM Factors

Operating System Considerations

Strictly speaking, the KVM should be independent of the computer's operating system (O/S). After all, you hook up a monitor and keyboard to a platform. Then you install whatever O/S you wish to run — DOS, Windows, NT, OS/2, Deskview, Mac System 8 or 9 or X (the current Mac O/S variations which are NOT PC compatible), Unix, Xenix (Microsoft's version of Unix), etc. Why should it matter to the switch what software is installed?

The simple answer is that the O/S should not matter, and the switch "should not care" what operating system is in use. But simple answers can be misleading. We have seen some KVM switches that have had problems with NT when it upgraded from version 3.51 to 4.x, and reports have come in that some switches don't work well with Linux.

In reality, in many cases the O/S does matter, and compatibility is a function of how well the emulation is implemented. The KVM must return the correct keyboard and mouse codes to the connected computers. For example, KVMs that don't understand about different scan sets inside the IBM-101 keyboard will have problems. To the extent that the O/S affects the code interchange, the KVM must be set up to interact properly with the O/S.

Intelligence in the KVM handles this interaction, and the intelligence is generally coded in firmware. If the firmware does not match the mouse or keyboard drivers in the O/S software, control can be erratic. You may have lags in mouse response, delayed keyboard response, constant "mouse button locked down" mode, or a complete failure to function. Sometimes it just takes a software update to a current driver or version of the O/S, or a firmware update on the KVM, to fix the problem.

Sometimes what appears to be an O/S compatibility issue turns out to be an indirectly related driver issue. There may be certain video or mouse drivers, for example, that are configured and selected along with the operating system. When you install or select a different O/S and encounter problems, you may inadvertently have selected these different drivers. For example, if the video driver changes from 640x480 resolution to 1024x768, a 15-inch limited-bandwidth monitor connected to the KVM may suddenly fail to display a satisfactory image. Changing a 'config' file or 'Control Panel' on the offending platform would correct such a problem

without any need for hardware changes or adapters.

If you have a concern about utilizing a particular operating environment with a KVM, consult the KVM manufacturer or a knowledgeable consultant with access to up-to-date information. Then, be sure to get a money-back or model exchange satisfaction guarantee just in case things don't work as expected.

Computer Hardware Considerations

It is easy to mistake O/S compatibility for other aspects of compatibility because some computers that use different operating systems ALSO rely on different electronic standards. Aside from issues of the proper connector type (for mating cables), the computer itself can affect compatibility. The IBM RS/6000 series, which are RISC-based computers that typically run the Unix operating system, are not compatible with a typical PC KVM handling Windows or DOS — not because of the O/S, but because of differences in keyboard scan codes... or possibly because the particular RS/6000 is being controlled via a serial port, not via a graphics/keyboard/mouse system. Some KVMs do handle the different scan codes, and some can provide serial control instead of relying on keyboard buffer/video display ports.

DOS, Windows and OS/2 typically run on Intel-based CPUs, and clones of those CPUs. This includes the Intel 286, through 586 (or Pentium) series chips, lower-end Celeron chips, AMD's K-series or advanced Athalon chips. Some KVMs have had difficulties with the first Pentiums (but, then again, so did Intel itself at one point).

The x-86 series chip is based on CISC architecture (Complex Instruction Set Chip). RISC (Reduced Instruction Set Chip) architecture is favored for running the Unix O/S and variants of Unix. Thus, if a Unix-based computer has compatibility problems with a particular KVM, it may be the O/S or the computer architecture causing the conflict, and you should consult the KVM manufacturer to resolve the issue.

Unix (and Unix variants) can run on Motorola 680xx series chips. Several computer manufacturers used these CPUs for Unix or other O/S's, including the original Macintosh O/S. Macintosh products migrated from the 680xx family of CISC chips

to the Power PC RISC CPU family several years ago (the Power PC architecture was a joint development effort of IBM, Apple and Motorola). IBM also markets Power PC based computers, including a number of RS/6000 models. The Power PC can be overlaid with various operating systems, including Macintosh O/S 7 through X, Windows (95, 98, NT), OS/2, and Unix. In summary, it is essential that you verify that a given KVMS will work not only with the operating system(s) you plan to use, but also with the particular hardware platforms on which those O/S's are running.

Network environments (Novell Netware, Banyan Vines, etc.) are NOT O/S's, but they can impact KVMS operation if someone patches the scan code set. Normally, the network environment will not matter because the KVMS is not involved in the network end of the connected computers.

Methods of Switching

We have already described, briefly, the methods of switching: direct selection via pushbuttons or displayed menus, indirect selection via step up/step down buttons, direct selection via keyboard commands, and scanning of connected computers in sequence. Let's discuss these approaches in more detail.

To some users, direct access to a given computer is essential. They do not wish to wait for the scanning to get to the platform of interest, nor do they wish to take the time to step through various platforms with incrementing (<|>) buttons. Manufacturers who provide direct access via push-buttons on the switch offer the simplest, most cost-effective approach for direct access. However, it may be necessary to physically place the switch at a location that is out of convenient reach of the operator. This may, for instance, permit many computer-to-switch cables to be kept short (which saves money and avoids signal degradation), and then the only longer cables are those run to the monitor, mouse and keyboard; since the KVMS can buffer these signals, the extra distance on this side of the switch does not necessarily cause any degradation. With the switch out of reach, however, another method of computer selection must be provided.

Keyboard controlled switching is one obvious answer; allow command keys or an escape-sequence-activated series of hot keys to select the computer being accessed. As implemented widely today, there is no need to modify the soft-

ware on the various computers to effect keyboard switching (you want the operation to be seamless to the computers). Another approach is to provide a remote control for the KVMS; some manufacturers do this, but the feature can be more costly than use of keyboard access, and it places another piece of proprietary equipment on the desktop. On the other hand, a remote control avoids any chance of accidentally issuing an incorrect command to a given computer when you had intended to issue a switching command. In some cases, a remote can save money – by allowing the switch itself to be closer to the CPUs. Here, multiple, short CPU-to-switch cables and one long switch-to-remote cable may be used instead of multiple long cables.

In reality, remote controls are most often used for specialized environments where there may be no access to a conventional keyboard (i.e., point of display systems, sales kiosks, etc.) A more recent and now widely available remote (or local) switch approach is the on-screen display (OSD) or menu-driven switch interface. Most of the OSDs today are similar in appearance (and there has been litigation between competitors over this issue), but appearances are not the key issue. For example, in some KVMS systems, the OSD will not be visible unless a given CPU is already selected and is generating a video signal; in this instance, the OSD uses the computer-generated Sync signal to throw up its message. The problem is that some computers will “go to sleep” and not put out any sync, or they may be shut off, and if you then have to rely on the OSD to select another computer... you're out of luck. You may have to switch in-the-blind just to get any OSD at all, then select the CPU you really wanted to control. Some OSD-equipped KVMS systems also provide for access security, system analysis and other special functions. There are obvious differences in the image quality and the nature of displayed information, but you have to look beyond the mere naming of CPUs to see how well an OSD works.

You may also wish to examine special features to see if they are important to you. Some switches, for example, offer a Broadcast Mode, in which keyboard commands can be sent simultaneously to multiple computers. This may save time when issuing shut-down commands to a rack full of computers in the event of an emergency, or for simultaneously initiating routine backup, loading new software, and so forth. Some KVMSs that provide for automatic scanning of various computers do so in a fixed sequence and at uniform dwell times (dwell is the

amount of time a given computer stays selected); other KVMs let you select a subset of computers to be scanned, let you arrange the order in which they are scanned, and let you set different dwell times for each computer so that you can spend more time viewing the most important-to-see platforms. To halt scanning when you see a screen requiring your attention, you may have to press a button on the KVM, use a keyboard command, or simply touch the mouse or keyboard.

The point once again is that you should look carefully not only for the presence of a feature, but at how the feature is implemented!

Other Issues to Consider

When selecting a KVM, consider its behavior with regard to switching delays, video glitches, proper operation of ALL keyboard features (caps lock and num lock indicators for example), correct mouse response and tracking, and overall reliability.

Also, consider whether it is possible to expand the number of switching channels without having to add another monitor and keyboard. Does the switch allow for an expansion chassis? Do you lose a port

on the base unit when you add an expansion switch, and how important is that in the context of the overall system? Do you have to operate multiple switch controls after expansion, or do you retain single-point computer selection capability? These are important considerations that may not be discussed in the manufacturer's advertising.

It is also worth considering whether and how the firmware can be upgraded for the switch. Changes in operating systems and computer architecture have, over the years, repeatedly rendered the firmware on various switches to be less than ideal, and in some cases have made the switch unusable. The ability to upgrade firmware should be considered essential since a relatively minor cost (or free) firmware upgrade can preserve a large investment in switch hardware and installation. On the other hand you would like to have firmware be reasonably stable before it ships. Some manufacturers have released tens to dozens of firmware revisions in the same time that other manufacturers have remained current with just a few releases; how often do you want to HAVE to upgrade firmware?

Multi-Console KVM Systems: The New Standard

The Explosion in Multi-Console Switching

System Architectures

The multi-console KVM system architecture you choose will impact the infrastructure of your data center in ways you might not expect. These systems come in a wide range of styles, with different feature sets, physical sizes, unit and overall capacities, and cabling requirements. Each different KVM topology requires various components that affect everything from rack space (vertical RU's) within individual racks to the data center's AC and KVM chassis interconnect wiring. In some KVM systems, components may require dedicated racks while others can be co-located in the racks with computers. In some cases, the KVM hardware may extend beyond the data center walls.

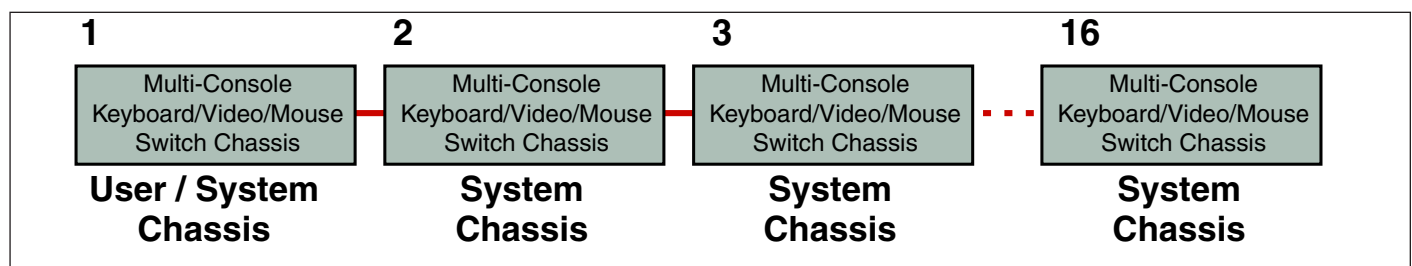
We have tried to demystify some of the generalities for you by identifying four primary switch topologies. We also provide a general overview of current component sizes and functions although it is not our intention here to describe specific products. Neither is it our intention to supply here, specific

system design concepts; we do generally describe how to optimize the functionality of any KVM system. The topologies covered here focus only on the basic architectures and not myriad combinations and permutations that can evolve in specifically designed and installed systems.

The three basic topologies are: Series, Star, and Expanded Star. Certain model KVM may be configured in more than one of these topologies. When more than one topology is mixed in a given system, that becomes a fourth topology... the Hybrid.

Series

The Series model is a simple to understand and easy to implement topology. All connections are made in-line (series) with the first chassis connected to the second chassis and the second to a third chassis and so on. In some models, the last chassis in the sequence is fitted with a terminator. The Series model is used in many single-console KVM switches supporting a dedicated port for expansion, but only one multi-console KVM system requires the Series model (some others support it but don't require it).

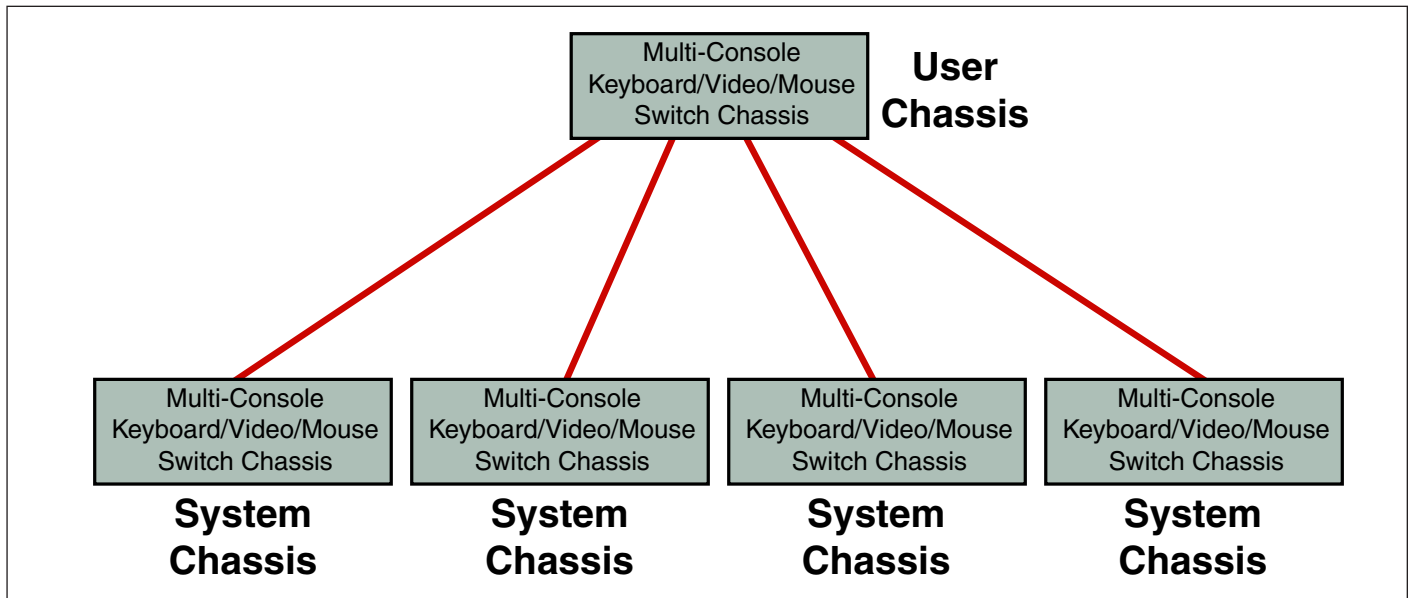


The Series Architecture is the Most Simple and Easy to Implement Multi-Console KVM Architecture

Limited Star

The Limited Star Model is popular for smaller-capacity KVM switch systems, single or multi-console. The connection between the first chassis and subsequent chassis' originate at the first chassis to which the console(s) is connected. This topology model is deemed "limited" because it is scalable on a single tier only. KVMs that depend on the Limited Star model typically use system ports (computer connection) for expansion purposes. To

establish a single data path between two chassis, a connection is made from a system port on the first chassis to a console or user port on the second chassis. KVM systems that use the Limited Star model have limited CPU capacity; a few such systems mix Limited Star in conjunction with another topology to somewhat expand capacity. If you have a large number of CPUs or plan to in the future, don't use a Limited Star system. (See diagram which follows.)



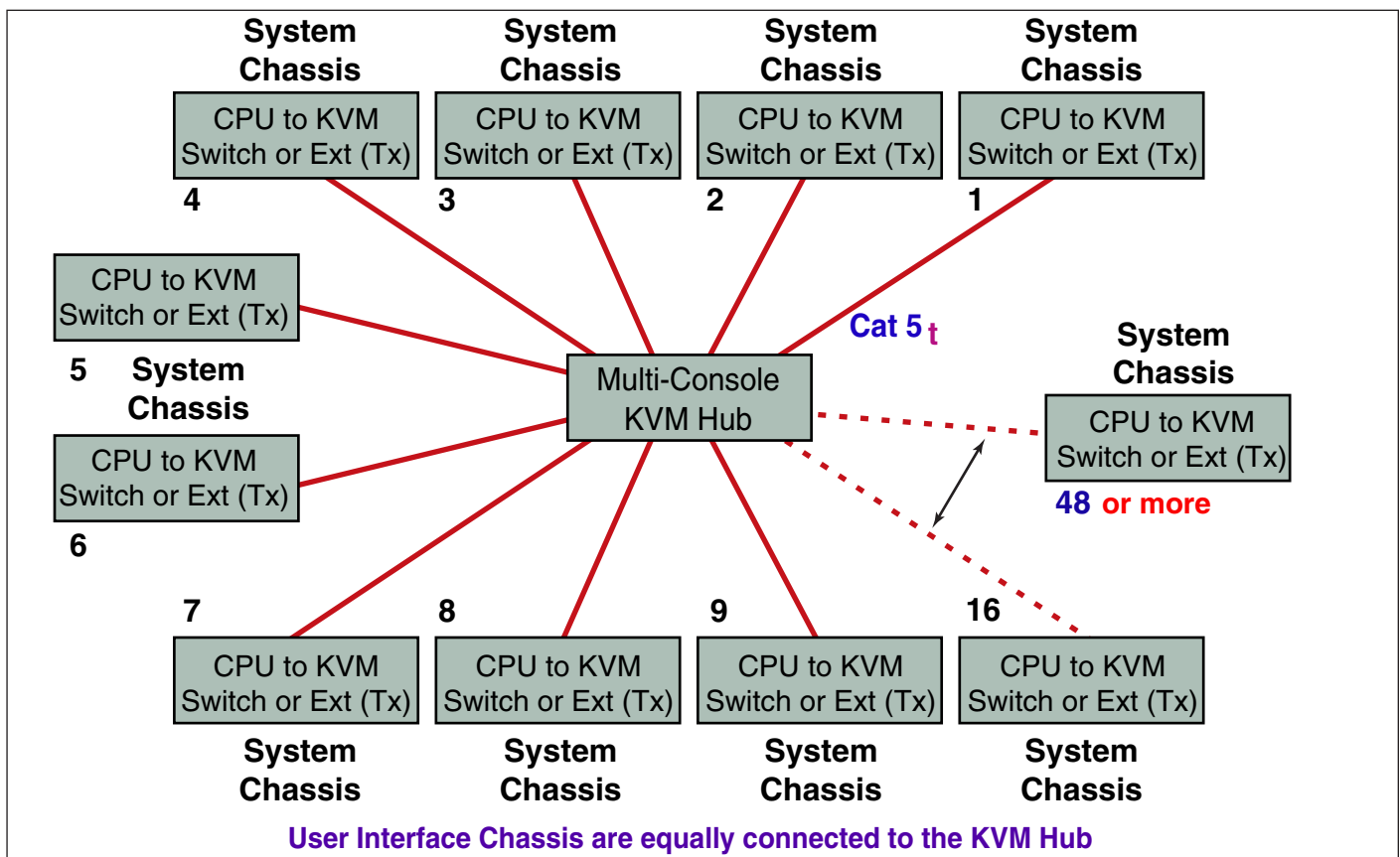
The Limited Star Architecture is a Popular Multi-Console KVM Architecture for Smaller to Mid-Capacity Systems

Expanded Star

The Expanded Star topology resembles a Limited Star model but offers extended functionality.

This Topology model is deemed the "Expanded" because of it is scalable across more than one tier and to a greater number of CPUs. It may also include provisions to connect a Limited Star model to any or all

of the primary legs. KVMs system architectures developed on the Expanded Star model will typically use Category 5 cable for interconnectivity between system components. KVMs systems based on the Expanded architecture provide high level support for consoles and computers, may combine a high capacity middle piece, and usually include redundant emulation support.

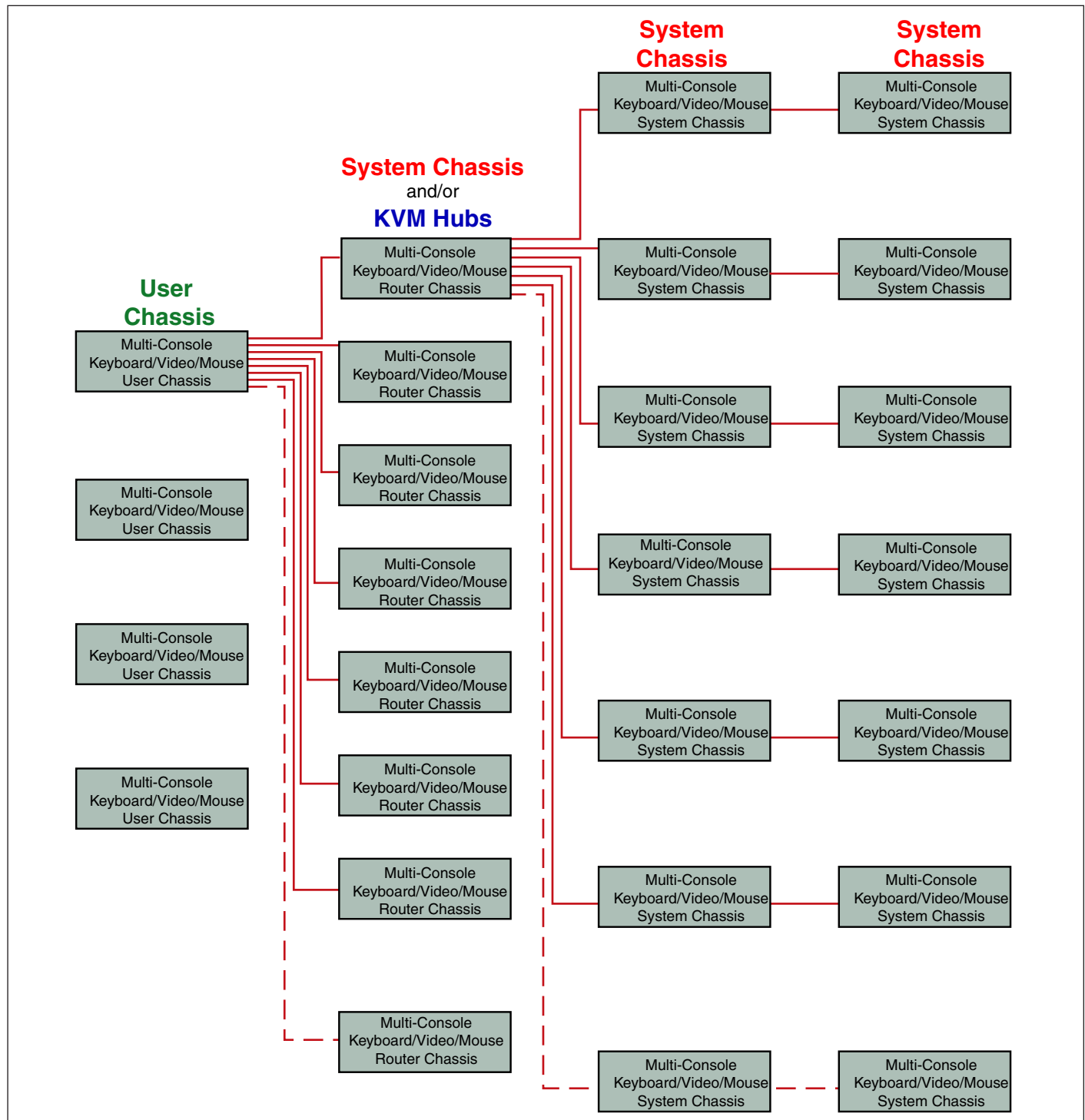


Hybrid

Three Hybrid Topology models are displayed to illustrate a minimum of set of topology options or alternatives. In these Hybrid models, any tier is capable of establishing a continued connection to another tier as either a Star or Series model. Displayed in Hybrid Figure A is a first tier chassis connected to the second tier and then to a third tier

via a Star model. The chassis connections between tiers three and four in Figure A follow the Series model. Hybrid Figure B illustrates a change in the tier three-to-four connection from Star to Series.

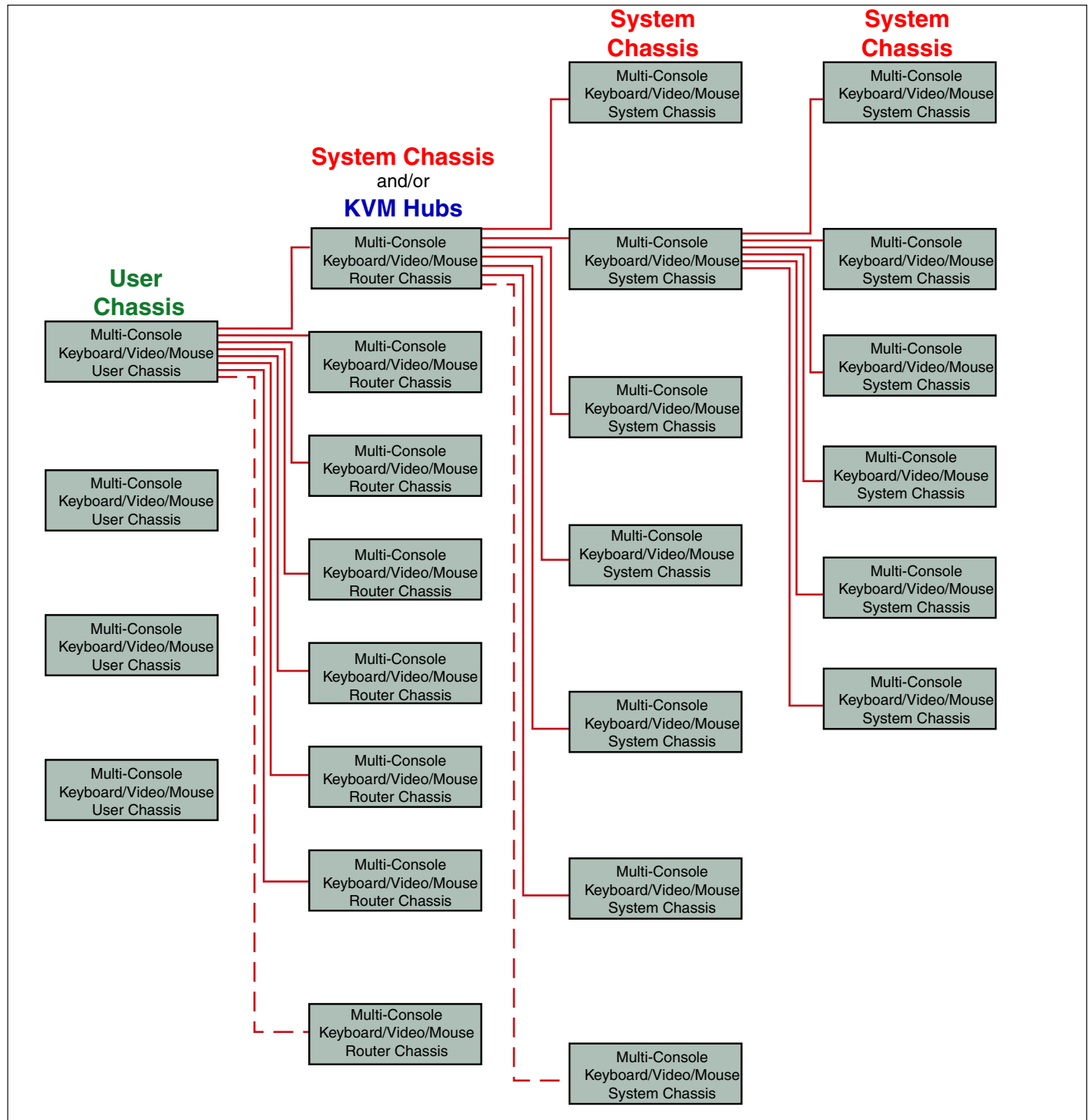
Series, Star and Expanded Star are combined to create the third Hybrid model, Figure C. In multi-console KVMs systems, the likelihood of degraded video quality is the primary factor restricting the tier



Hybrid Figure A. Tier 1 (left) Stars to Tier 2, Tier 2 Stars to Tier 3, and Tier 3 Stars to Tier 4.

depth. Secondly, the KVMs firmware's ability to address downstream chassis may also be a factor (addressing and naming larger numbers of CPUs requires more memory, which may not be available). In the case of video, manufacturers generally specify the number of hops a KVM system can effectively achieve without deterioration of the video signal. In some applications where the opti-

imum underlying conditions exist, the KVM system may perform well beyond the stated specifications. This is under optimum conditions though, with the ideally specified cabling; manufacturers state limitations based on a more conservative view of how their products will be used. Additional single console KVM switches may be used to extend these products beyond the stated chassis-



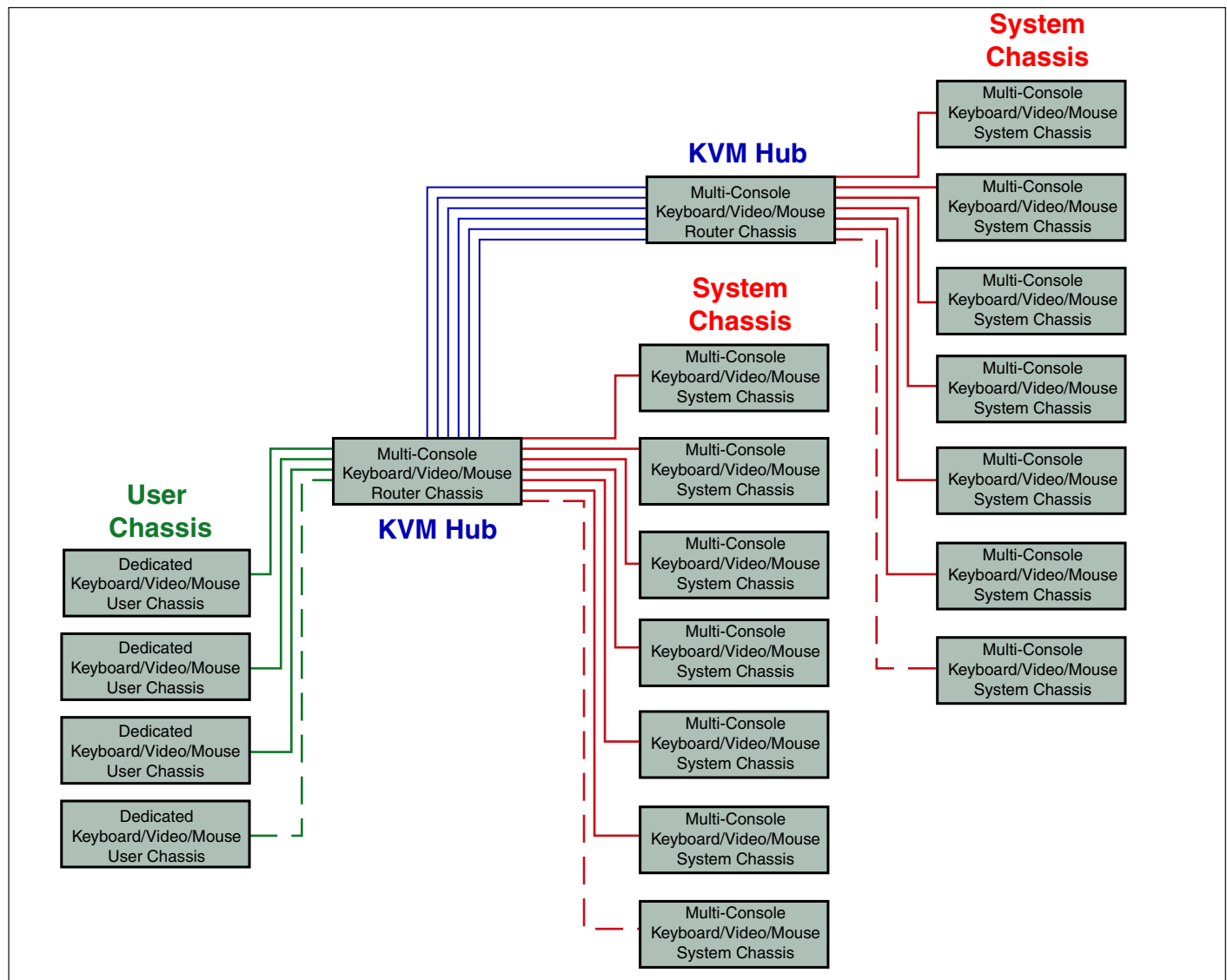
Hybrid Figure B. Tier 1 (left) Stars to Tier 2, Tier 2 Stars to Tier 3, but Tier 3 to 4 changes to a Series Connection.

to-chassis hop limitations. Combining secondary KVM switches is useful because they provide additional buffering (amplification) for the video signal. They also extend the reach of the firmware's addressable ports because secondary KVM switches supply their own selection memory and On-Screen-Display (OSD) menu(s).

The topologies noted above are representative of global implementations. They do not address the differing hardware requirements of each system. We discussed the general variations in hardware implementations here. For a more detailed description of individual products, you may check the web sites or speak with sales associates of the actual manufacturer(s). For a more accurate evaluation, we recommended that you discuss your application with an all-product integrator who understands exactly what you are look-

ing for. It may take longer than a day for an integrator to configure two or three products, but you stand a better chance of gaining an insight into the best products and architecture for your application.

Smaller KVM systems based on the Star model are straightforward, easy to configure and they install quickly. The components are usually comprised of individual KVM switch chassis, plus a variety of cables. They have a pre-configured fixed port design ranging in capacity from four, to eight, twelve or sixteen ports accessible by two to four consoles. They include a means to expand by interconnecting the chassis (usually from the console ports of one unit to the system ports of another). A complete system includes a user (console) and system (computer) interface chassis, though these functions may be mixed within the same chassis.



Hybrid Figure C. Here the Series, Star and Expanded Star Architectures are All Utilized in a Single KVM System

The larger the KVMS system, the more complicated it gets! KVMS systems that utilize the Expanded Star and Hybrid models are configured with user and system chassis but also include a middle section for KVM signal routing. Think of the middle section as a “router” or “hub” though it does not handle IP or data at all; it may or may not support direct connection of additional, local computers.

There are three distinct approaches to how the hardware is designed in the Hybrid model. In all of these, inexpensive category 5 cable usually is the interconnecting medium. The hardware located near the computer will include simple extension technology to compress and transmit KVM signals over the Cat 5. The manufacturer’s design determines whether or not switching is actually performed near the computers. Some KVMS systems transmit the signal to a central hardware piece where the distribution matrix is activated; consoles in the same system may also be connected via Cat 5 extension technology. When switching is initiated at the computer hardware, console access is authenticated before the console can select any given computer within the KVM switch. Again, the middle section provides KVM signal routing, but as noted above, this section of the KVMS system may or may not provide the primary switching functions. Some large KVMS switches may require an additional, external hardware component that uses software to manage the KVMS, or it may serve to simply connect one hardware address to another hardware address (console to computer).

One recent manufacturer’s recent announcement and release of a new multi-console KVMS system may be characterized as simply a Star model. But, if the new product is combined with the already existing Limited Star model available from this producer, the new product can be implemented with much wider concept to resemble the Expanded Star model or Hybrid model.

There are inherent benefits to each approach, and your optimum system will depend on a few variables. These variables include (but are not limited to) the level of protection from component failure, the level of redundancy and your approach to implementation. Whether the KVMS system is to be installed prior to the hardware, all at once, or phased in with the computer hardware will help narrow your options. Large KVMS systems can concentrate distribution and throughput with just a few compo-

nents or across several hardware pieces. The latter incorporates a higher level of redundancy and will provide protection from component failures regardless of the product brand. To properly evaluate the best your options, you will need to weigh your organization’s priorities as you review the features of each KVMS system.

Physical Considerations

The hardware installed for the topologies discussed above come in a variety of packages and sizes. System Chassis will range from one U, RU or “rack unit” (one RU = 1.75 inches) to seven U’s (12.25 inches) and support from one to sixteen computers at the rack. The middle pieces (KVM Hubs) range from ten to fourteen U’s with the latest KVM Hub announcement requiring only 1 Unit of rack space. Depending on the product, User Console Chassis will equally range between one U “unit” to three U’s (5.25 inches) supporting one to eight consoles connected to the system backbone.

Smaller switches implemented with the limited start topology can use as many as seven units of rack space providing support for up to eight consoles connected to thirty-two computers.

Cables will be routed from the CPU’s to a local switch chassis. Each local switch chassis will be interconnected to one or more central switch chassis (or KVM routers) before being distributed for multi-user access. Sometimes local switches at the CPU racks are eliminated by placing the interface in a single KVMS main chassis and instead using KVM extension technology to connect to individual CPUs. The size (or number of ports) a local chassis will support varies from two to sixteen. This means that the number of KVMS chassis required to support eight servers in a single cabinet will be four, two or one. Optionally a sixteen port chassis would support enough servers for two to four cabinets—typically. Of course with larger servers that each occupy a third to half a cabinet, particularly if equipped with external RAID systems, an eight-port KVMS chassis will support two or three cabinets. Do your racking and permitted wiring practices support point-to-point cabling across multiple cabinets, or do you have to dip under the floor or up to a ladder rack when bridging cabinets? In each case, the rack layouts and cabling requirements must be planned in great detail if the installation is to proceed smoothly.

Platform Support

There is native support for multiple computer platform architectures like DEC, Mac, Sun, SGI and Intel or even ASCII terminals, but such support is not present in all KVM products. Advertisements and product brochures promote many KVM products for multi-platform support, whereas in reality native support may apply only to a few types of computers, with special adapters being required for support of other types. While some multi-console KVM switches simply don't provide you with a full range of platform support, in many cases this will not be a deciding issue. Administrators who do have a mix of platforms should be alert to the subtleties of platform support available from a given switch. For example, can the Sun keyboard with its specialized function keys be used at the console, or must the Sun platforms controlled via KVM translation from PC keyboards?

Multi-console KVM Switches without native support can obtain video sync conversion, or keyboard and mouse protocol translation through the use of adapters. One important aspect of Native vs. Adaptive platform support is the cost. In an environment where a high number of computers represent a mix of platforms, the cost of installing protocol converters can be extremely expensive. If you select a KVM Switch based on its price alone, and fail to consider the cost of external converters and/or special adapter cables, the overall cost may end being much higher than a product you initially dismissed due to sticker price.

Controlling and Tracking Usage in the KVM Switch System

The traditional approach to KVM switching has been based on an external, hardware-based solution. Users did not want any software or firmware added to their servers so the switch manufacturers created hardware that did the job entirely external to the servers. However, the latest trend and product releases include external software and/or hardware as a control mechanism or enhancement. We discuss the control methods and security implementations here in a brief review of the industry's options.

Most early KVM Switches had pushbuttons on the front panel to select the various connected computers. Later, keyboard hot-key sequences were added to allow a user to control switching between ports without touching the switch. Hot-keys were a

welcomed solution for consoles that used extension devices to position the console remote to the switch, but it often required the users to maintain long list of the computers and where they were positioned. Both of these methods are still available in KVM Switches and more manufacturers have installed front panel buttons on newer models. One company had an early insight and produced the industry's first On-Screen-Display (OSD), while another manufacturer developed special maintenance features, both which are accessible through the embedded firmware.

The later two features have proven to be valuable functions for the end-user, and invaluable to the latest products. More than fifty percent of the products available today include the OSD as a standard feature and even more products offer it as an option. The On-Screen-Display allows the consumer to access and select computers by name. OSD uses an overlay that is generated by the switch and displayed on the console screen. It is independent of computers on the switch or the peripheral hardware at the users work area. Additional management features provide control of security and special maintenance functions of the KVM or the entire KVM system. Some of the larger KVM systems include user tracking, set-up for dual monitors, or port I/O control through the OSD. The most useful function, though, is extending the reach and users ability to identify and select computers that are on large KVM backbones and may even be located in the next room or the next building.

While the control methods above have all been external to the computers controlled by the KVM Switch, the most recent trend is moving towards software. The use of software provides the end-user with an even better control mechanism. The underlying benefits of database software presents an extension to the OSD that can be recorded on a much larger scale. One manufacturer has implemented a control tool that combines hardware and software to manage the actual security authentication and selection method. This system works independently of the actual switching hardware. Yet another product may combine the embedded firmware and an external software piece to manage security while switching is managed by the KVM Switch hardware. In all cases where software is used external or within the KVM Switch, you'll be getting a higher degree of tracking features that will help you to manage the KVM system.

Emulation Services

The primary reason why KVM switches moved rapidly from passive to active devices was because keyboard and mouse emulation was highly desirable and no satisfactory solution could be achieved with passive circuitry. Intel-based PCs running DOS or Windows, the main platforms and OSs being switched at the inception of these switching systems, required that a keyboard (and later a mouse) be connected to the computer. As you probably know, powering up a computer without these peripherals connected would (and generally still does) result in a boot error message and a failure to subsequently recognize the peripherals if even they are later connected. This is why passive switches were awkward; one would have to switch to each computer and leave it selected during the boot process... a slow and annoying procedure. Some platforms and operating systems would probe for keyboard or mouse presence after bootup, and if the passive (non-emulating) switch happened to be set so the user peripherals (console) were assigned to a different computer, that probing computer would hang.

The implementation of active keyboard and mouse emulation services meant that every computer connected to the KVM switch would get a port response that told the computer it had a keyboard and mouse present... even though there was only one on the system. In order to perform this function, the KVM switch was equipped with integrated circuits that interacted with the attached computers as though they were the actual keyboard or mouse, only the data was set to pass through the KVM system to the connected user peripherals only when they addressed a specific computer.

The concept of emulation is thus fairly straightforward. Indeed, in the PC world, there are only a handful of chips used to support keyboard and mouse interface. Nonetheless, the implementation of emulation for a KVMS manufacturer is less than simple. For one thing, there are many variations in keyboards and mice, some involving timing issues, some involving scan codes, and other involving data format. What keyboard and mouse will actually be used with a given KVMS? The KVMS manufacturer cannot generally specify this, and so the product must be broadly compatible. On the other end, each computer manufacturer has options as to which physical devices to support, which chip (or chipset) to use inside the computer, and what coding and protocol options to utilize. Again, the

KVMS manufacturer must try to accommodate the broadest possible spectrum of devices and options.

All the above considerations multiply many-fold when a KVMS is built as a multi-platform capable system. In such cases, the switch now must support different connections, widely different coding ([see the details of keyboard and mouse coding in the technical explanations of this document](#)), and in many cases it must add emulation of *monitor* sense data. As you may know from reading the sections of this document dealing with the [Details of Video for Computers](#), some operating systems and computer systems draw windows based on the available screen real estate, and thus they must know the pixel-map capability as well as, in many cases, the color depth and refresh rate of the connected monitor. Apple Macintosh, Sun Sparc and some Silicon Graphics platforms, as well as certain IBM RS/6000 and XGA-video platforms, require video sense feedback. VESA (a standard for video) publishes a DDC specification for defining monitor characteristics and communicating this between monitor and computer. KVM switches built to support platforms that require video sense data must be able to be automatically or manually set to convey this data to attached computers in such a way that the monitor(s) used can display the incoming video signals.

Today a manufacturer of KVM switching (or extension) products can purchase chips that perform keyboard and mouse emulation. Chips or circuit cards are available to perform terminal emulation. Yet inclusion of these off-the-shelf products in a KVMS system is no guarantee of broad scale emulation. Because operating systems are regularly updated and computer hardware undergoes regular cycles of innovation and change, so too must KVMS products be regularly updated. In most cases, it is the firmware, not the switch hardware, that will fail in the face of change. You may experience this as a hung or erratic mouse, a locked up or inappropriate keyboard response, or random changes in shift lock states as KVM signals experience out-of-sync conditions. You may not even be able to use a certain computer with a certain KVM switch. That is why KVMS systems should include support for firmware updates, whether via plug-in ROM or flash-upgradeable ROM.

Firmware updates, though, are not a magic bullet. You don't want to HAVE TO install new firmware every few months because a KVMS maker neglected to account for this or that variation in

products. As a rule, the KVM firmware will change less often than the operating system is updated. In the authors' experience, many well-made KVM systems have been in service for years before requiring any firmware changes. Be sure to look into this aspect of the system you're considering.

Capacity and Scalability

Through out this documents we briefly mention the capacity of some of the available products. This section provides you with a comprehensive look at the range of sizes and what you can expect from a KVM system in maximum capacity. The smallest multi-console KVM Switch is a simple two console by two computer switch - each console can select between the two ports. The largest multi-console KVM Switch in a single chassis supports eight consoles on a backplane that supports thirty-two computers. There are many variations in between and the most common chassis sizes you're likely to encounter will support four, eight, twelve or sixteen computers accessible by two to four consoles. Many of these chassis designs are depicted in the section on [System Architectures](#).

Complete multi-console KVM systems starts with a capacity of thirty-two computers accessible by as many as sixteen consoles. The highest support available in a single KVM Hub or KVM Switch is one hundred and ninety-six computers accessible by sixty-four consoles. You will find that most multi-console KVM systems can be cascaded to expand the systems overall capacity. The Limited Star topology is the most restrictive, but KVM signals from various banks of these products can be combined at the users desktop using a single console KVM Switch. Manufacturers are making many advances in their technology and we have noticed new product releases that are installable as an independent system or combined with a smaller system offering a valuable scalability. A midrange system might support four consoles to two hundred and fifty-four computers while the largest KVM systems can support well over three thousand computers with as many consoles as one might imagine. The final capacity for the largest systems might be dependent on the User Access ratio. There are design approaches that allow you to place eight to sixteen computers accessible through two or more data paths established that would be established between the distributed hardware. These systems

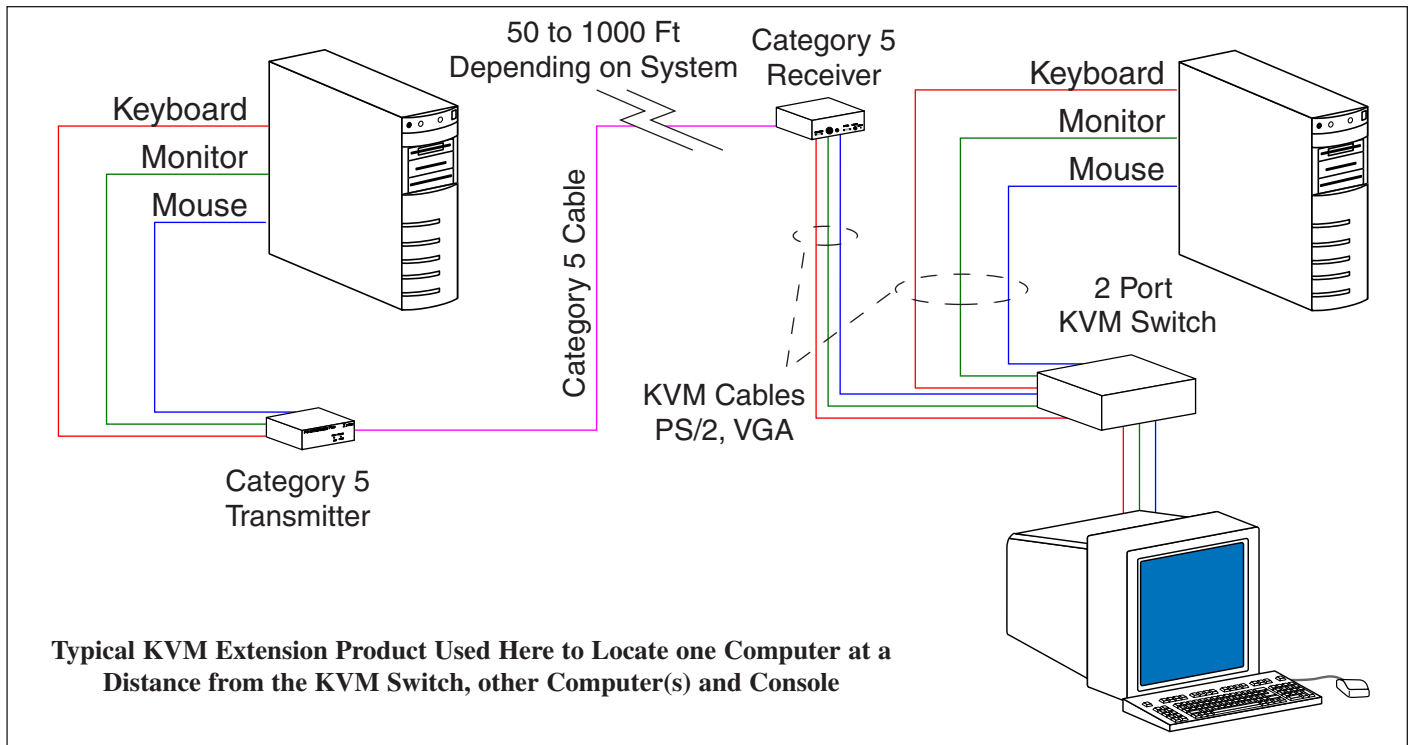
can support over three to four thousand computers attached to the backbone of a large scale KVM switch system. If the design specification dictates a one to one ratio, you might only get two to three thousand computers on the backbone. Obviously, only the largest data centers need to be concerned about these capacities, but there [will be price range issues associated with the two approaches that we discuss shortly](#).

Extending the Distance – Local and Long Distance

We briefly discussed the generalities of KVM Extension Devices earlier in [What Are KVM Extension Products](#). Here, we discuss the details of KVM Extension Devices because, increasingly, they may comprise a substantial portion of a KVM system's technology. The original KVM extension technology used bulky PVC-jacketed shielded cable for the transport medium. These became largely obsolete when Category 5 Extension products came to market because Cat 5 cables were non-proprietary, widely available in different lengths, and easier to pull. The original Cat 5 extension products used two Cat 5 cables to transport keyboard, monitor and mouse signals. Dual-Cat 5 technology is still in use to maintain legacy compatibility within some product lines; it passes keyboard and mouse over one Cat 5 and the video over another Cat 5; if audio signals are conveyed, they may share the keyboard/mouse Cat 5 or travel on yet a third Cat 5 cable. The newest technology transmits a minimum of keyboard, monitor and mouse signal data over a single category 5 cable. The more advanced implementations of this technology may support additional signals including stereo microphone and speaker data as well as serial data. These products function by compressing and/or multiplexing data at one end of the link, and transmitting from end-point to end-point over a single cat 5, then decoding the data at the other end.

Category 5 Cable Usage in KVM Products

Category 5 is a standard for construction and performance of telephone or network cables; Cat 5 UTP (Unshielded Twisted Pair) cables have four twisted pair of copper conductors and the cables terminate with 8-pin modular telephone-style RJ-45 male connectors. Shielded Cat 5 cables exist but are not generally used in KVM applications; be sure to check the manufacturer's spec for a given prod-



uct. Also, some cables are wired “straight through” whereas others are wired for “crossover,” the latter having certain conductors switching position on one of the RJ-45 connectors. *You cannot interchange straight-through and crossover cables, and if you inadvertently use the wrong one in certain KVM extension or switching products, you can permanently damage the equipment; be sure to use the proper type of Cat 5 cable!* In network applications, standard Cat 5 cable is specified, under ideal conditions, for data rates (bandwidth) to 150 MHz and distances to 100 meters (328 feet). Enhanced Cat 5 cables may carry higher bandwidth signals and/or extend the distance for data transmission. However, the same Cat 5 cable when used for KVM extension may not give equal results in terms of distance or bandwidth because the KVM signals are different than those used in Ethernet TCP/IP data transfer environments. The purely digital square waves of a TCP/IP clocked transmission differ from the separate Red, Green, Blue analog video traveling down different pair of Cat 5 conductors, and differences in the phase (timing) of these signals due to different twist rates in each pair of wires within the Cat 5 cable will cause R-G-B “spread” or ghosting/shadowing on the monitor. Perhaps surprisingly, some enhanced Cat 5 may perform *worse* than ordinary Cat 5 in certain KVM extension applications.

Unlike the 100 meter/328 foot standard for data transfer, the same copper wire Cat 5 cables can deliver satisfactory results for KVM transmission

with cable lengths up to 500, 800 or even 1000 feet depending on how the manufacturer’s circuitry compensates for losses and time delay, and depending on the maximum video resolution one wishes to convey (higher resolutions won’t travel as far satisfactorily). Until recently, only one option – glass fiber – existed for transmitting KVM signals over greater distances. Fiber systems can deliver KVM data from 1,000 to 10,000 feet. This is a costly solution in just the hardware alone and organizations still spend additional dollars to run glass cable between end-points.

Fiberoptic Cable for KVM Extenders

Fiber optic based KVM extenders can transmit keyboard, monitor, mouse, audio and other serial data signals over glass fiber. As many as three manufacturers offered these products in the past, but only one viable product survives, and it carries a high price tag. The other two products have either been taken off the market, or are not compatible with most of the available switches. The survivor is the only product that has cross compatibility with most of the different KVM Switches – though not with all of them.

Remote KVM Access Via Network or Dial-Up

The latest technology, as refined in 1999 by two different KVMS manufacturers, allows remote consoles to connect to a single computer or to multiple computers on a KVM switch via the network backbone for cross-campus access, or through an out-

of-band dial-up connection for wider area remote access. In its current state, however, this new technology does not yield video resolution great as can be obtained with fiberoptic, and the mouse response is noticeably sluggish; such connectivity is offered primarily for maintenance access rather than for prolonged remote work sessions. The physical construction of these remote access products is similar. Both utilized specially prepared computers running a Remote/Host software application. Even though these products are pre-configured and shipped with a default software selection, you actually have options for the access software that these products can handle. The access devices are pretty much off-the-shelf high-end Intel processor-based computers with their own hard drive, RAM, and NT Server operating systems. What is different is that the KVM manufacturers include special digitizing boards that are able to generate KVM signals from the remote client serial data stream so that the remote access device puts out keyboard and mouse signal; most computers with remote access software merely respond to remote input while their own keyboard/mouse ports are idle. The output of the remote access device, in turn, can control a single computer or the console connection of a KVM Switch where it provides access to any of the switched servers. The remote user selects which computer he would like to control either through OSD or a similar software menu. [See "Controlling and tracking User activity on the KVM Switch"](#)

There are a number of differences in using such remote access devices, compared to using a pure remote access software-on-server approach. In this KVM scenario, no software is added to the servers, so security is much less apt to be compromised, and the computer cannot be impaired by any software incompatibility. In addition, if a server must be rebooted, the remote client requesting the reboot can observe and control that process right back to "blue screen" or CMOS setup, something not possible with a pure software solution. Moreover, only one network or modem connection is required to access any number of servers.

Dollar Factors\$ — Obvious and Hidden

You can compare the price tag on a given switch, including its required cables and accessories, to another and get some feel for the relative costs of this KVMs versus that one. And you can compare the cost of the KVMs with a single monitor and keyboard to that of one monitor and keyboard (and mouse if applicable) per computer. Such an analysis, however, will not really give you a clear picture of the true cost of implementing KVMs.

KVMS Direct Costs

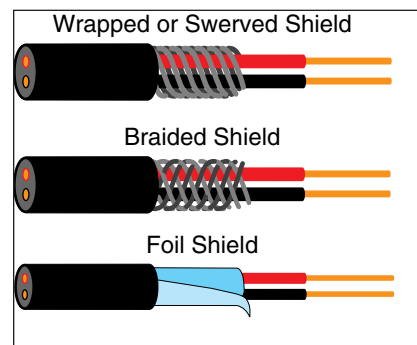
Active keyboard/video switches for a particular type of platform are priced over a wide range. Some platforms are more costly to switch (with wider bandwidth or special connectors or instance), some can support longer cables, some have more sophisticated technology, and some are just plain better values. Some switches offer extraordinary capabilities, such as multi-platform compatibility, extreme distances (beyond the typical 5 to 30 feet between computer and switch), or multi-user access, so their costs may be significantly higher.

We suggest that you add up the cost of the switch plus cables and necessary accessories (power supplies, remote controls, mounting hardware). Then subtract the cost of all the monitors (and keyboards and mice... and racking) you won't need, and divide this by the number of computers being switched. If the result is a positive number, you get an idea of the direct switch cost per switched computer. Negative numbers indicate how much you'll save per switched computer. Of course, you will have indirect savings, too, such as reduced floor space requirements, better personnel efficiency (don't under-estimate this factor), lower power usage, and lower HVAC (air conditioning) costs.

Cables

Since the first edition of this White Paper in 1995, cable pricing has become more competitive. In addition to KVMs that use specialized cable sets (these still make sense due to their locking connections), many KVMs models now use standard, separate keyboard, video and mouse cables. These have brought down cabling costs in some instances. Some manufacturers still require you to daisy-chain connections from one computer to the next on the way to the switch; this may save in overall cable

length, but it makes things more complex if you want freedom in layout of individual computers. And, as stated previously, not all cables are of equivalent quality; cables with controlled impedance cost more, but impose less signal degradation. (If the capacitance between conductors is incorrect, the cable becomes a low pass filter, reducing bandwidth and impairing video quality.) Adequate shielding is important to reduce interaction and interference; cables differ drastically in this regard. For example, they may have swerved (wire wrapped), braided, or foil shield; these



The Appropriate Type of Shielding for The Application is One of Many Factors Affecting Cable Quality

methods of shielding trade flexibility against shield effectiveness and durability. Coaxial cable can be beneficial here, though it is typically more costly and less flexible than other cables.

Earlier KVM extension and interconnect technologies occasionally used Category 5 cabling to convey keyboard, mouse and video over longer distances. Then, it was typical to use two Cat 5 cables per pathway. Today, advances in KVM encoding have made it possible to pass these signals over a single Cat 5 cable, and to include serial data as well as stereo microphone and speaker signals as well. Cost reduction and miniaturization even make this practical to convey connections from individual CPUs to the KVMs switch, thus simplifying the



Monaural Microphone and Stereo Speaker Mini-Phone Plugs on a KVMs Cable Set

cabling and further saving precious rack space. On the other side of the switch, existing Cat 5 cables can now be used to run the keyboard/monitor/mouse control console out to the user's office.

Connection between the switch chassis on larger, multi-chassis systems is an important con-

sideration. Some models favor daisy-chain only, or star-only topologies which limits installation flexibility. Other models permit a mix of topologies. Some models require special interconnect cables, and in more and more cases, ordinary Cat 5 cabling has become the preferred method because it is readily available, relatively inexpensive and uses less space per connection. The maximum distance from chassis-to-chassis and across the entire system from CPU to user console also differs with various makes and models.

Review these factors as they apply to your situation before making a purchase decision.

KVMS Reliability and Support Costs

There is no question about it... when you use a KVMS, you are creating potential point where a failure can affect your access to multiple computers. Thus, KVMS reliability is a crucial concern. *The KVMS should be manufactured by a vendor with a proven track record, using top-quality components and extensive quality controls.* Its design should be conservative, and should be such that a switch failure in one channel does not cause computers on other channels to be affected, nor does it damage the computer. Ideally, there should be a way to patch around or otherwise “hot wire” the system for emergency access in the event of a failure in any component that affects more than one CPU.

In general, the most common source of failures in electronic devices is the power supply, so it is important to have a reliable supply. Not only can the loss of power immediately cause all operation to cease, the power supply itself generates heat which, if transferred to nearby electronic circuits, can shorten component life. Some manufacturers try to reduce heat concerns by using external power supplies. Power “bricks” that are large enough to power a multi-port KVMS can fall out of an outlet, making them a potential weak point, so secure external supplies carefully if you use this type. A few manufacturers of KVMSs have models that use the same power that would have powered the keyboard on a given computer to power the corresponding circuitry in the KVMS; with one such external “power supply” (computer) per port, such KVMS have a distributed power supply so no single failure will bring down the entire KVMS, and there is no power supply inside to generate heat. However, if the KVMS draws too much power from a computer, it can blow an internal fuse on the computer (typically a motherboard-mounted

pico fuse); while this can be replaced, it is inconvenient, so you will want to be sure that the computer can support the power drain of such a switch. The largest multi-user KVMS systems today have field-installable hot-swap capable power supplies, or even dual-redundant power supplies, a feature you may wish to look for.

Reliability issues notwithstanding, anything can break and it will (or so says “Murphy’s Law”). You will want to look closely at the warranty and, equally important, at the support available from the manufacturer and from the vendor that supplies you with the KVMS. You will want to know that replacement product is readily available. And you will want to select a product made by a manufacturer who will be around a year or several from now.

A related issue is whether the product will continue to keep up with technological advances in your computer setup. Look for features like upgradeable firmware if you really plan to keep that KVMS for a long time because it’s almost certain that changing computer hardware and operating systems will demand updated KVMS firmware.

Make the right choices in these areas, and your KVMS will deliver not only initial cost savings, but ongoing savings year after year. Make a poor choice, and downtime can eat up those savings in a hurry.

Efficiency & Productivity — Less Tangible But Very Significant Sources of Savings

Because the KVMS enables an operator to sit (or stand) in one place while checking tens to thousands of computers, that operator can be much more productive. While the KVMS may require a fraction of a second (or even a second) to change from one computer to the next, this is less time than it takes the operator to stand up, much less walk 5 or 50 or 500 feet to another computer as would be required without the KVMS.

Because there are fewer monitors and keyboards, there are fewer components to be maintained. This saves time and money in the long term — over and above the direct acquisition costs or power costs.

In situations where a single operator would otherwise be working in front of multiple CRTs, the KVMS instead lets the operator work with a single, ideally-placed monitor and keyboard. This

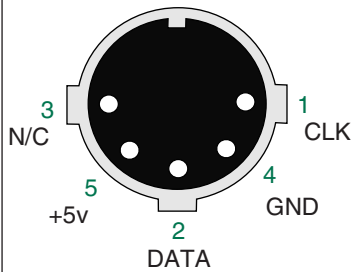
will reduce RSI (repetitive stress injury) so that the KVMS actually saves an unspecified amount in direct and indirect medical and workman's compensation costs. This also positively impacts workforce productivity.

Particularly in small office environments, the KVMS goes a long way toward reducing visual and physical clutter. The cleaner, neater layout facilitates operator concentration, thus improving productivity. When you are dealing with personnel earning \$50,000 to \$150,000 annually, a few percent greater productivity can add up to a lot of dollars annually — possible enough to pay for the KVMS in the first or two of operation.

Finally, the greatest hidden savings may be that the KVMS allows you to stay in the current space and avoid a costly move or build-out. It is not unusual for the installation of KVMS to cut floor space requirements down to one half or one third of an unswitched configuration. If you combine KVMS with a suitable racking system designed for multiple computers (not just bakery racks or warehouse shelving), you will save even more floor space while significantly improving maintenance access so it takes less time to service the computers. It is common to see floor space requirements drop to from one-third to one-fourth that of the non-switched, non-racked computer room.

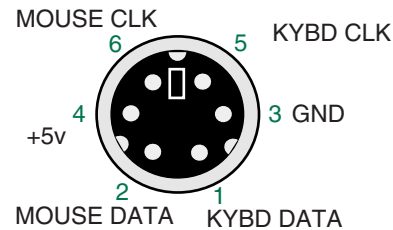
Appendix A: Connector Diagrams

Pin Arrangements are Shown from Mating Side of Connectors (Not to Scale)



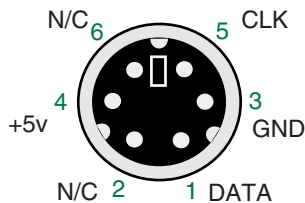
PC/AT Keyboard

5 Pin DIN
Female in Chassis



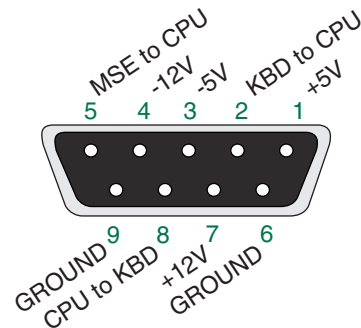
Newer-Style SGI Keyboard (and Mouse)

6 Pin Mini-DIN
Female in Chassis



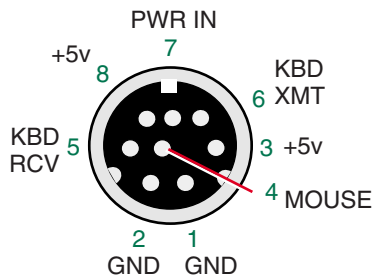
PS/2 Keyboard (same as the PS/2 Mouse)

6 Pin Mini-DIN
Female in Chassis



SGI Personal IRIS 4D/20 & 4D/25 Keyboard (& Mouse)

DB-9 Keyboard Cable
Female in Chassis

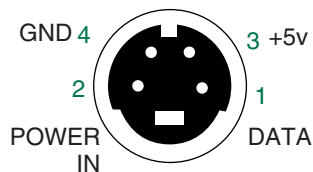
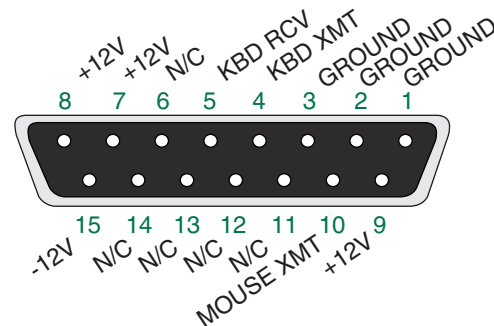


Sun Keyboard (and Mouse)

8 Pin Mini-DIN
Female in Chassis

SGI Indigo, Crimson and other SGI 15-Pin Keyboard (& Mouse)

DB-15 Keyboard Cable



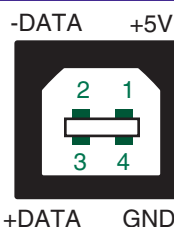
ADB: Mac Keyboard, Mouse & More

6 Pin Mini-DIN
Female in Chassis



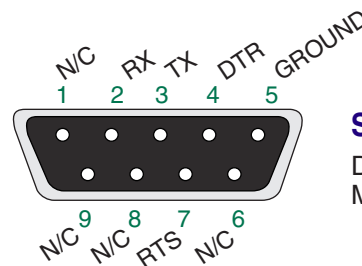
USB Type A (Universal Serial Bus) Keyboard, Mouse, etc.

4 Pin USB Type A
Receptacle for Mating to Chassis or Ext. Cable



USB Type B (Universal Serial Bus) Keyboard, Mouse, etc.

4 Pin USB Type B
Receptacle for Mating to Chassis (not for Ext. Cbl.)

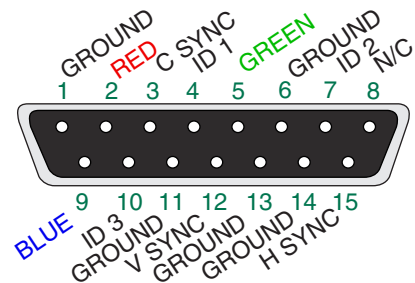
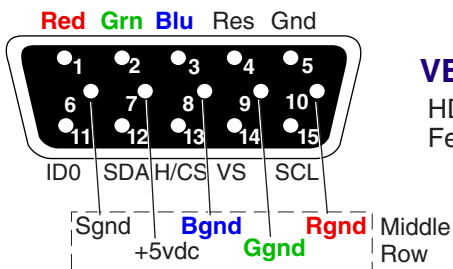
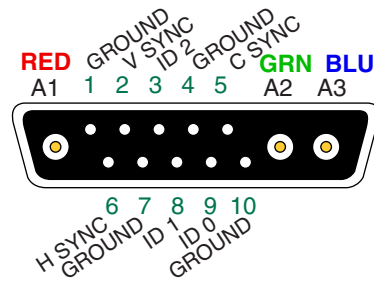
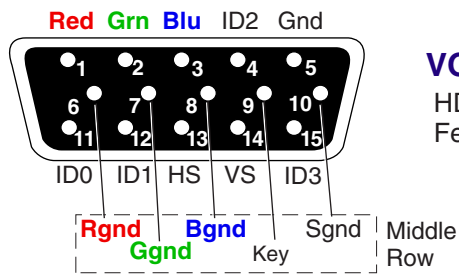


Serial Mouse

DB-9
Male in Chassis

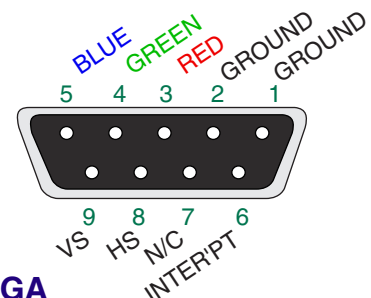
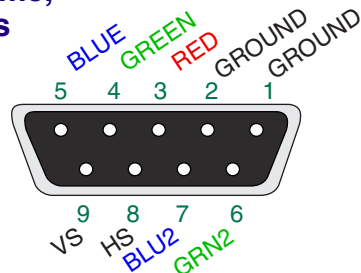
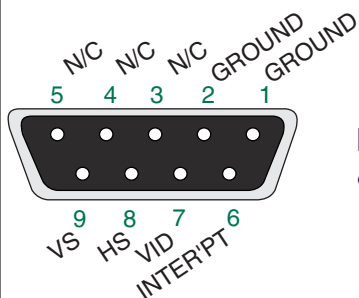
Connector Pin Configurations for Keyboard, Mouse and USB (ADB and USB also handle other data besides Kbd & Mse)

Pin Arrangements are Shown from Mating Side of Connectors (Not to Scale)



TTL Video: The Early Digital Signal in 3 Types

DB-9 Connectors, Female in Chassis



Connector Pin Configurations for Various Video Connections Commonly Used in KVM Switching and Extension.

Appendix B: KVMS Glossary

A

ADB – Apple desktop bus. A connector and signal standard developed by Apple Computer for use in their original Macintosh series of computers. ADB is primarily intended for keyboard and mouse, but also supports such items as dongles, modems and graphics tablets. ADB is more recently being replaced by USB connections on iMac, G3 and G4 series Apple computers.

ac - Alternating Current. An electrical current that reverses its direction of flow at regular intervals (ac, 60 hertz [cps] means reversing direction of flow each half cycle or 120 times per second).

Access path restrictions - In a K/V/M switch, this refers to a limitation on the number of users (consoles) which can simultaneously view/control different computers. The restriction to access (for viewing or controlling) is due to limitations in the number of data busses in a given switch chassis or a limitation in the number of discrete data paths between switch chassis (i.e., the “paths” for data).

active element - Those components of a circuit that have gain or direct current flow. They change the basic character of the applied electrical signal by rectification, amplification, switching, etc. Examples include diodes, transistors, and SCRs.

A-D converter - Analog-to-digital converter. Circuitry which accepts a continuously varying voltage or current input and converts it to a digital output. The input may be dc or ac, the output serial or parallel, binary or decimal.

ADC – See A-D converter.

address - A specific location where data is stored in a computer circuit memory; a numerical or alphabetical designation of the storage location of data

alphanumeric - Code structures using letters and numerals, often with added special symbols.

am (amplitude modulation) - Modulation in which the amplitude of a wave is the characteristic subject to variation.

American Wire Gauge - Abbreviated AWG. Numerical descriptor system for wire size, based on specified ranges of circular mil area. American Wire Gauge starts with 4/0 (0000) at the largest size, going to 3/0 (000), 2/0 (00), 1/0 (0), 1, 2, and up to 40 and beyond for the smallest sizes.

ammeter - Instrument designed to measure current flow in amperes. Available for either alternating or direct current. A milliammeter measures current flow in milliamperes, and a microammeter in microamperes. See galvanometer.

amp (abbreviation) - See ampere.

ampere - Abbreviated A or amp. Practical unit of electrical current; the current flow rate (i.e., quantity of electrons passing a point in 1 second). One ampere is one joule of electrons moving past a point in one second. A potential of 1 volt will send a current of 1 ampere through a resistance of 1 ohm.

amplifier - A circuit, device, or component which provides an output signal essentially identical to the input signal, but at a higher power or signal level.

amplitude - The magnitude of variation in a changing quantity from its zero value. The word requires modification - as with adjectives such as peak, maximum, rms - to designate the specific amplitude in question.

analog - A signal which is continuously variable and, unlike a digital signal, does not have discrete levels. (A slide rule is analog in function.)

ANSI - An acronym for American National Standards Institute Inc. Operates a voluntary certification program.

ASCII - An acronym for American Standard Code for Information Interchange. Pronounced “ass-key.” A 7-bit code used to represent 128 unique letters, numbers, and special characters. An eighth bit is used for parity.

ASP - A filled direct burial telephone cable used in areas subject to rodent attack. It consists of a filled cable core, corrugated aluminum shield, corrugated steel tape, flooding compound and polyethylene jacket.

ASP - An acronym for Application Service Provider. Something like an ISP (Internet Service Provider) but instead the ASP sells end users the temporary access to computer programs via an internet connection instead of using purchased/licensed programs residing on the users’ local servers or workstations.

AT – Refers to the IBM PC-AT, an early personal computer. The keyboard connector on this machine was a large, round 5-pin DIN connector. Subsequent PCs used the same “AT-Style” keyboard connector for many years, though it has gradually been superseded by the smaller PS2 style connector and by USB connectors. The data format for signals in these various connections is also different.

asynchronous transmission - Transmission in which time intervals between transmitted bits may be of unequal length. The transmission is controlled by start and stop bits which frame each character or string of data.

attenuation - A reduction in power which occurs during signal transmission through cables, broadcast or other means. May be produced intentionally by placing an attenuator in a circuit. Attenuation is generally expressed in decibels or decibels per unit of length/distance.

AWG - An acronym for American Wire Gauge.

B

backbone - The part of a computer network that carries the heaviest traffic. It is the main trunk cable from which all connections to the network are made. It may be comprised of copper cable or fiberoptic.

backplane - Area of a computer or other equipment where various logic and control elements are interconnected.

balanced line - A two-conductor line in which both conductors have the same impedance with respect to ground. Since noise pickup is equal on both conductors, common-mode interference is cancelled at the load.

bandwidth - Defines a range of frequencies that can be accommodated. For example, for a bandpass filter, it is the frequencies passed. For a transmitter and receiver, it is the frequencies that can be transmitted or received. For a transmission system, it is typically the highest frequency transmittable (assuming the lower ones can usually be handled). A circuit that passes frequencies from 1,000 Hz to 10,000 Hz can be said to have a bandwidth of 9 kHz. The limits of the “band” are generally defined as those upper and lower frequency points beyond which the signal level is attenuated by 3 dB or more relative to the middle of the passband.

baseband signal - A signal transmitted at its original frequency, without modulation or multiplexing.

baud - A unit of signal speed, the reciprocal of the shortest bit interval. Sometimes equivalent to bits per second.

bipolar - A circuit which utilizes positive and negative power supply voltages. Typically low-power amplifiers may use ground and a positive power source of 3 to 12 volts whereas a higher power amplifier may use ground and both pos. and neg. power supplies. Line driver amplifiers that are made to send signals down very long cables often use bipolar circuitry.

Birmingham Wire Gauge - The Birmingham Wire Gauge (BWG) was used extensively in Great Britain and the United States for many years, but is now obsolete. Its use is now limited, though it is sometimes used with galvanized steel wire for cable armor. Generally AWG applies in K/V/M and computer circuitry.

bit - The smallest element of information in binary language. A contraction of BInary digiT. These characters in system (computer) language signify “on” and “off” (1 and 0). Word length, memory capacity, etc, can be expressed in number of bits.

black box - A term used loosely to refer to any assembly or subassembly, usually electronic, that can readily be installed or removed from a specific location in a larger system by an operator not familiar with its detailed internal structure.

BNC Series - A radio frequency connector covered by Military Specification (Mil Spec). It has an impedance of 50 ohms, and is designed to operate in the 0 to 4 GHz frequency range. BNC is a quick connect/disconnect system using a pin-and-cam bayonet coupling.

braid - A weave of metal fibers used as a shield covering for an insulated conductor or group of insulated conductors. When flattened, it may be used as a grounding strap.

breakdown voltage - The voltage at which an insulator or dielectric ruptures, or at which ionization and conduction take place in a gas or vapor.

broadband EMI - Interference (electro magnetic interference) generated over a wide range of frequencies. EMI sources such as electric motors can induce noise in various circuits or cables through inductive coupling.

broadband signal - A signal transmitted by being modulated onto a higher frequency carrier wave.

B & S - Brown & Sharpe Gauge, a wire diameter standard that is the same as AWG.

buffer - A device or circuit element which stores information temporarily during data transfers. Often used to isolate one part of a circuit from another or to facilitate data transmission synchronization.

burn in - Operation of a circuit or equipment to stabilize all components and reduce failure rates.

bus - Originally, uninsulated conductor (wire, bar, etc); may be solid or hollow, round or rectangular. Sometimes used to indicate bus bar. Conceptually, a bus is a major circuit path to which other circuit elements apply or from which they derive power, signals or data. One or more primary conductor paths used to transmit information from any of several sources to any of several destinations.

bus bar - A heavy bar or strap (usually of copper) for carrying heavy currents, or serving as a common connection between several circuits. Often used in datacomm cabinets or data centers to provide a common electrical ground.

bus network - A network topology in which nodes are all connected to a single line serving as the bus.

byte - A group of eight bits that define a character or data word.

C

cable - Either a stranded conductor with or without insulation and other coverings (single conductor cable), or a combination of solid or stranded conductors insulated from one another (multi-conductor cable). In fiber optics, a jacketed fiber or jacketed bundle in a form which can be terminated.

cable assembly - A completed cable with its associated connectors and/or hardware.

cable clamp - A device used to give mechanical support or strain relief to a wire bundle or cable.

CAD - An acronym for Computer-aided design. Use of the computer in engineering design activities.

CAM - Computer-aided manufacture. Use of computer to aid and direct manufacturing activities.

capacitance - The property of an electrical non-conductor (dielectric in a capacitor) that permits the storage of energy as a result of electric displacement. The unit of capacitance is the Faraday, though typical capacitor values are usually expressed in microFarads or picoFarads (millionths or billionths of Farads).

capacitive coupling - The coupling of energy from one conductor to another as a result of the distributed capacitance between them. With resistance, one component of capacitive reactance.

capacitor - A device to store electricity and release it when needed, this consists of conducting plates or foils separated by thin layers of dielectric. The plates, on opposite sides of dielectric layers, are oppositely charged by a source of voltage, and the electrical energy of the charged system being stored in the polarized dielectric. Capacitors block the flow of direct current (dc) while allowing the flow of alternating current (ac) and are therefore used as elements in filter circuits.

carrier - A higher frequency upon which voice or coded data can be superimposed (modulated).

cascade - To take the output of one amplifier and apply it as the input signal to the second amplifier, and the output of the second to the third, and so on. Each amplifier is called a stage, and stages used successively are said to be in cascade. Sometimes the term is used interchangeably with Daisy Chain.

Cat 5 - Abbreviation for Category 5.

catastrophic failure - The complete loss of a device's ability to perform its required function. Most commonly describes failures that are sudden or involve rapid deterioration.

Category 5 - A standard for communications cabling. Cat 5 cables are comprised of four pairs of twisted conductors (a total of 8 wires). These terminate in a particular pattern in an RJ45 modular plug. Normally Cat 5 cables are used in Ethernet networks and provide a bandwidth of up to 100 MHz at distances up to 100 meters (328 feet). There are many variations including "enhanced" Cat 5 cable with bandwidths of 200 MHz or higher, though to achieve high bandwidths all connections, connectors, cables and devices must be installed correctly, carefully tested and certified to operate as advertised. Bandwidth and distance are just two of many parameters that must be checked and certified for proper performance; others include attenuation, crosstalk, near end crosstalk, attenuation-to-crosstalk ratio, delay, delay skew, and ultimately even equal-level far-end crosstalk, powersum and return loss. Simple LED go/no-go testers are not adequate to certify cable performance. Cat 5 cables are generally UTP (unshielded twisted pair) but some applications utilize STP (shielded twisted pair) cable (which is stiffer, trickier to ground, has more loss, and is not better for most applications). A newer standard, Cat 5E, is recommended for gigabit speed Ethernet over copper if fiberoptic is not used.

cathode-ray tube - Abbreviated CRT, this is the high-voltage driven, phosphor faced "picture tube" found in traditional computer monitors, television receivers, and oscilloscopes.

CCITT - An acronym for Consultative Committee for International Telephone and Telegraph. An international standards group.

central processing unit - Abbreviated CPU. The section of a computer that contains the arithmetic, logic, and control circuits. In some systems it may also include the memory unit and the operator's console. The abbreviation CPU is often used to describe an entire microcomputer, including the actual CPU as well as RAM, ROM, I/O ports, drives, power supply, and so forth; although this is not technically correct, it is a widely accepted shorthand.

channel - The path along which signals are sent; the medium can be wire, optical fibers, or free space.

characteristic impedance - The ratio of voltage to current at every point along a transmission line on which there are no standing waves.

chip - A single substrate on which all the active and passive circuit elements are fabricated by semiconductor manufacturing techniques. Its function can be simple or complex. Often used interchangeably with IC (integrated circuit).

circuit - 1. A complete path through which electrons can flow from the negative terminal of a voltage source through a conductor and back to the positive terminal. 2. The interconnected combination of a number of elements or parts to accomplish a desired function (e.g. filter, switch, amplifier).

circuit element - A basic constituent of a circuit, exclusive of interconnection.

CISC - An acronym for complex instruction set computer. The alternative to a RISC system. Typical CISC CPUs include the entire Intel x86 series and the Motorola 68000 series.

cladding - An outer layer on a fiber optic core which promotes total internal reflection of light and also serves as a protection medium.

clear - To replace information in a storage device or register by zero (or blank, in some machines). Also frequently used as being synonymous with "reset," even in cases where neither memory nor counters are involved.

clock - The device in a digital system which provides the continuous train of pulses used to synchronize the transfer of data. A clock circuit is generally built using a crystal oscillator for stability.

CMOS - An acronym for Complementary Metal-Oxide Semiconductor. Also refers to popular MOS integrated circuits that use both p-type and n-type material for the channels. This allows very dense packaging and low power consumption.

coaxial cable - A transmission line consisting of two conductors concentric with and insulated from each other. In its flexible form it consists of either a solid or stranded center conductor surrounded by a dielectric. A braid is then woven or swerved over the dielectric to form an outer conductor, and a waterproof plastic covering, normally vinyl, is placed on top of the braid. The degree of flexibility in coaxial cables is indicated by the terms, flexible, semi-rigid, or rigid.

coaxial ribbon cable - Ribbon cable consisting of parallel coaxial conductors joined together in a flexible insulating material and designed for mass termination.

color coding - The selective placement of color on a terminal or contact to aid in its identification and to assure proper selection of the correct wire size and crimping tool.

color depth - Refers to the number of bits of information used to encode the color of a given pixel on the screen. 1 bit is monochrome (on/off). Typically gray-scale monitors use 2, 4 or 8 bit color depths to represent 4, 64 or 256 phosphor intensities respectively (in just one color). Color monitors use 4, 8, 16 or 24 bit color depths to represent 16, 256, 32,000 or 16.7 million colors respectively.

common-mode EMI - Interference that appears between both signal leads and common reference plane (ground) and causes the potential of both sides of the transmission path to be changed simultaneously and by the same amount relative to ground. Common mode EMI can induce noise or unwanted signals when various systems (KVM switches, extensions, and computers) are interconnected.

common-mode impedance coupling - The coupling of energy from one circuit to another that results when two or more currents flow through a common impedance.

components - Any items used in conjunction with another item in its manufacture.

concentric - A central core surrounded by one or more layers of helically wound strands in a fixed round geometric arrangement. Different diameter circles with exactly the same center point.

conductivity - The ability of a material to conduct electric current - usually expressed as a percentage of copper conductivity (copper being 100%). Conductivity is expressed in terms of the current per unit of applied voltage. It is the reciprocal of resistivity.

conductor - Wire or any method used by electricity to go from one place to another.

conduit - Usually a metal covering to go over wire to protect it from damage.

connector - A coupling device employed to connect conductors of one circuit with those of another circuit. Used to provide rapid connect/disconnect mating with a pc board, posts, or another connector. A housing becomes a connector when it contains the specified number of contacts (with conductors) to make it functional.

connector assembly - Includes more parts than just a housing and contacts. It usually consists of a housing (with contacts), or a shell (with modules or inserts and contacts), and the necessary hardware to hold the assembly together and/or make the assembly a functional connector.

console - A set of computer peripherals used for I/O control. Typically includes a minimum set of a keyboard, a video monitor and (often) a mouse. A broader definition includes audio (speakers and/or microphone) and other serial or RS-232 device. The console for many Unix-based computers and hardware devices (such as routers) is terminal that uses ASCII communication code via RS-232 or similar serial interface and does not use a mouse. May also refer to a piece of furniture from which one or more computers or video monitors are viewed and controlled.

console access ratio - A mathematical expression of the number of consoles (connected keyboard, monitor and mouse) to the number of available computers in a given KVM switch system. Also see user access ratio.

contact - An electrically conductive item designed for use in a multi-circuit connector, for convenience in making multiple electrical connections.

contact resistance - Measurement of electrical resistance of mated contacts when assembled in a connector under typical service use. Electrical resistance is determined by measuring from the rear of the contact area of one contact to the rear of the contact area of its mate (excluding both crimps) while carrying a specified test current. Overall contact resistance would be the wire to wire measurement.

continuity - A continuous path for the flow of current in an electrical circuit.

controller - An instrument that holds a process or condition at a desired level or status as determined by comparison of the actual value with the desired value.

core - The central part of the fiber optic in which light is actually projected to its destination.

CPU - Abbreviation for central processing unit.

crosstalk - A magnetic or electrostatic coupling which causes the unwanted transfer of energy from one circuit (the disturbing circuit) to another circuit (the disturbed circuit). For instance, video sent down one cable may appear, via crosstalk, as a shadowy ghost on another video circuit.

CRT - abbreviation for cathode ray tube.

CSA - An acronym for Canadian Standards Association. A nonprofit, independent organization which operates a listing service for electrical and electronic materials and equipment. The Canadian counterpart of the Underwriters Laboratories in the USA.

current - The rate of transfer of electricity from one point to another. Current is usually a movement of electrons, measured in amperes, milliamperes, and microamperes.

current rating - The maximum continuous electrical flow of current recommended for a given wire or circuit, expressed in amperes.

cutoff frequency (f_c) - The frequency at which a filter provides 3 dB of loss (half the power relative to the passband).

D

DAC - See digital-to-analog converter.

daisy chain - A group of three or more devices (such as K/V/M switches) or circuit elements interconnected to one another in series. A cable assembly with common wires jumpering three or more connections/connectors. The term is also used as a verb, implying to connect multiple devices in series-jumpered manner. See Series (topology).

damping - Reduction of mechanical or electrical energy by means of an energy-absorbing medium. Damping counteracts resonance, or acts to stabilize a state change in a switch.

data base - A computer application involving the ordering and manipulation of a large body of data.

data bus - In a KVM switch, an independent path for conveyance of video, keyboard and mouse signals (possibly also serial and audio). The number of discrete data busses dictate the number of independent consoles that can simultaneously access/communicate with different CPUs in the switch chassis.

data link (or path) - Equipment which permits the point-to-point transmission of information in data format.

data path - Describes an interconnection between two or more chassis of a KVM switch system through which a console can communicate with an attached CPU. Similar to Access Path.

daughterboard - A printed circuit board that is inserted into a connector which is mounted onto another pc board (motherboard). A board-to-board application with the daughterboard being the plug-in, usually smaller board. Also called daughtercard. In some KVM switches, optional or updated functions are installed by means of daughterboards.

dB - abbreviation. See decibel.

dc - Direct current. An electrical current flowing in one direction only.

dc method - A technique of daisy chaining K/V/M switches. The preferred dc method is through dedicated ports on the KVM Switch chassis whereby an Out Port of one switch is cabled to the In Port of the next KVM switch and so forth. Alternately the console (user) port of one KVM switch may be connected to the system (CPU) port of the next KVM switch, and so forth to create a daisy chain.

DEC – Digital Equipment Corporation. One of the earliest makers of mini-computers, and software for them. DEC subsequently added powerful micro-computer based servers and to their product offerings, as well as peripherals such as printers and drives. Compaq now owns DEC.

decibel - A unit expressing the ratio of two voltages, currents, or powers, abbreviated dB. One dB is equal to 20 times the common logarithm of the ratio of two voltages across or two currents through equal loads. One dB is also 10 times the common logarithm of the two powers. One decibel is approximately the smallest change in audible power that can be recognized by the human ear, whereas 3 dB is approximately twice the volume.

decoder - A device used to convert information from a coded form into a more usable form (e.g. binary-to-decimal decoder). Normally the unit receiving the data uses a decoder.

degradation - A deterioration in performance or quality, usually attributed to a specific cause or causes. For example, the differential capacitive reactance in the conductor pairs used to convey red, green and blue signals will cause a degradation in video quality as cable length increases.

demodulator - A device used to extract data or signals when a carrier wave is employed as the means of data transmission. To obtain the data transmitted, the demodulator must receive and filter out the carrier wave from the signal with which it was originally modulated. See decoder.

derate - To reduce the rating of a device for improved reliability, or to permit operation at high ambient temperatures.

dial-up - An expression to describe the ability to initiate a station-to-station telephone call, and effect the station connection desired purely as a result of dialing. Commonly referred to as a telephone modem-based connection.

dielectric - A material that serves as an insulator (i.e., it has poor electrical conductivity). A measure of resistance to voltage exhibited by a given insulation.

dielectric withstanding voltage - Maximum potential gradient that a dielectric material can withstand without failure. Value obtained for the dielectric strength will depend on the thickness of the material and on the method and conditions of test. The significance is that a material with high dielectric properties may still fail to insulate if the voltage involved is sufficiently high.

differential mode EMI - Interference that causes the potential of one side of a signal line to be changed relative to the other side; the type of interference in which the interference path is wholly in the signal transmission line.

digital circuit - A circuit typically having two states, on or off (value 1 or 0) - as contrasted to an analog circuit whose output is continuously variable (linear). Digital circuits transfer or process only numbers (even if they are used to represent other things) whereas analog circuits may transfer or process a variety of continuously variable or modulated signals.

digital-to-analog (D/A) converter - A device which transforms digital data into analog data by translating a digitally expressed value to a representative voltage level. Typically used for converting stored or processed video (or audio waveforms) into to displayable video (or playable audio). Also known as a DAC.

DIN - abbreviation for Deutsche Institut fur Normung. A West German standards organization.

DIN connector - Any connector conforming to DIN standards, although often referring to a circular DIN connector popular in audio applications. There are dozens of connected-related DIN standards. For example, computers DIN defines many keyboard and mouse connectors: DIN 5 are used for older AT-style keyboards, whereas mini DIN 6 are used for PS-2 type keyboards and mice, and mini DIN 8 are used for Sun keyboards.

diode - A two terminal, single junction semiconductor - a rectifier - which exhibits different conduction characteristics depending on the polarity of applied voltage. A forward biased conventional p-n diode has a low impedance. Reversing the polarity results in a reverse bias diode and a high impedance. A diode normally passes current in one direction only. Some diodes emit light and are known as LEDs (see light-emitting diodes).

DIP - Abbreviation for dual-in-line package.

distortion - An unwanted change or addition to a signal or waveform when it is amplified. This definition excludes noise which is an extraneous signal superimposed on the desired signal.

distributed-element filter - A filter whose filtering properties, such as capacitance and inductance, are distributed uniformly along the length of the filter.

driver - 1. Small programs that control external devices or execute other programs. 2. The amplifier stage preceding the output stage in a KVM switch, extender transmitter or other device. 3. The portion of a particular type of loudspeaker that converts electrical energy into acoustic energy and feeds it to the small end of a horn (this is actually a compression driver).

dual-in-line package (DIP) - A family of rectangular integrated circuit flat packages which have leads on the two longer sides. The package material may be plastic or ceramic. DIPs can be integrated circuits, packages of resistors, and other circuit elements. On some KVM switches and extenders, DIP-mounted miniature switches (DIP switches) are used to set interface characteristics, logical addresses, and so forth.

duplex, full - Method of operation of a communication circuit whereby each end can simultaneously transmit and receive information.

duplex, half - Permits one direction, electrical communications between stations. Half duplex may permit operation in either direction, but not simultaneously. Therefore, this term is qualified by one of the following suffixes: S/O for send only, R/O for receive only, or S/R for send or receive.

E

E - Symbol used for voltage. Also written e.

EAROM - Acronym for Electrically Alterable Read Only Memory. A reprogrammable ROM in which each cell can be individually erased by a special electrical process.

EBCDIC - Extended Binary-Coded Decimal Interchange Code. An 8-bit code used to represent 256 unique letters, numbers, and special characters.

edge connector - A connector into which the edge of a printed circuit board is inserted.

EEPROM - Acronym for Electrically Erasable Programmable Read Only Memory. A reprogrammable ROM that can be reprogrammed by means of specially applied signals. EEPROMs are often used to store firmware in KVM switches, and can be exchanged to upgrade the firmware.

electromotive force (EMF) - See voltage.

electrostatic discharge - The sudden discharge of electrostatic charge that occurs when a charged conductor is grounded.

EMI - Electromagnetic interference. Unwanted electrical or electromagnetic energy that causes undesirable responses, degraded performance, or complete malfunctions in electronic equipment.

emulator - An electronic circuit or computer program that performs functionally like another circuit or program; for example, a computer of one manufacturer emulating that of another manufacturer, or a KVM switch emulating presence of a keyboard and mouse to a connected computer.

encoder - A device which translates information from one form (code) to another (e.g. decimal to binary encoder). Normally, an encoder is used in the device sending the information. An encoder can be created on a general-purpose computer using appropriate software, as contrasted to using a dedicated electronic device or chip for encoding.

EPROM - Erasable, programmable read-only memory. A ROM in which the programmed data can be erased and the chip reprogrammed; it differs from the RAM in that the erasing and reprogramming requires special equipment not part of the system in which the EPROM is used.

Extender – In the context of computers, this is a device which allow the keyboard, video monitor and mouse (and sometimes other peripherals) to be located at a greater distance from the computer than would otherwise be possible using conventional cabling. Typically, conventional cabling is not usable for more than 10 to 20 feet. Extenders incorporate special electronics to allow that distance to be stretched to greater distances. Copper cabled extenders yield distances of 300 to 800 feet (dedicated copper cables or ordinary Cat 5 cables depending on the model), and fiber optic cabled extenders can go as far as 1 to 2 miles (depending on the model and type of fiber used).

Extension Products – See Extender.

F

f - Symbol for frequency.

Farad - Unit of capacitance.

feedback - The recycling of a portion of an output to the input of the circuit.

positive feedback - Recycling of a signal that is in phase with the input to increase amplification. Used in digital circuits to standardize the waveforms in spite of any anomalies in the input. (A pat on the back?)

negative feedback - Recycling of a signal that is 180 degrees out of phase with the input to decrease amplification. Used in linear circuits to stabilize performance and minimize distortion. (Thumbs down?)

ferrule - A short tube. Used to make solderless connections to shielded or coaxial cable. When made of a magnetically absorbing compound such as ferrite, the ferrule can serve as an RF (radio frequency) filter element. Often, ferrite ferrules of about 3/4-inch diameter by 1-1/2 inch length are seen on video monitor cables to reduce radiation of interference from within the monitor, though the cable and out to nearby circuits.

fiber optics - A technology in which light is transmitted through an optical fiber, typically a glass fiber. Most often used as a transmission link connecting two electronic circuits.

filter - A network of resistance, capacitance, and inductance designed to pass certain frequencies and attenuate all others. The main types are low pass, high pass, band pass, and band reject. Also refers to certain software routines that block or reroute digital data based on specified criteria.

firmware - Software in hardware form, as, for example, KVM keyboard and mouse emulation routines in ROM.

flange - A projection extending from - or around the periphery of - a connector, and having holes that provide for mounting the connector to a panel, or to a mating connector.

flash memory - a form of EEPROM which can be reprogrammed in place, within its final installed device, by means of a program file which is directed to it. This differs from a conventional EAROM or EEPROM that must be removed and placed in a special ROM burner device in order to be reprogrammed. Flash memory (flash ROM) is used to store firmware in an increasing number of KVM switches, making it easier for users to keep their equipment up to date once installed.

floating ground - A grounding technique in which circuit grounds (return paths) are isolated from earth ground.

frequency - The number of complete cycles per unit of time - used for periodic quantities such as alternating current, sound waves, or vibrating objects. Frequency is generally expressed in hertz (cycles per second), kilohertz, megahertz, or gigahertz. Hertz is often capitalized as it is the name of an individual (Henrich Hertz), so abbreviations are Hz, kHz, MHz, and GHz.

frequency response - The measure of how the gain or loss of a circuit, device, or system varies with frequency. Generally defined as the passband above and below which the level falls by 3 dB (or more) relative to the midband level.

G

gain - An increase in signal parameter (i.e. voltage, current, power). Gain is a ratio frequently expressed in decibels (dB).

garbage - Unwanted, incorrect, or meaningless information in memory, transmission media, or other electronic circuit.

ground - A connection - intentional or accidental - between an electrical circuit and the earth, or some conducting body (e.g. a chassis) serving in place of the earth. Also, reference level for signals.

ground loop noise - Noise that results when different points of a grounding system are at different potentials and thereby create an unintended current path. This can be a problem in KVM extenders and some KVM switches, particularly where the devices at each of two locations are connected to AC power sources with different or unrelated ground potentials. Sometimes the use of ground breaking adapters or optional power supplies can reduce or eliminate this noise; sometimes an additional device-to-device chassis ground conductor is useful.

H

handshake - A multistep connection routine. A verification by the central processing unit that a computer data terminal has correctly identified itself, and all systems are ready to initiate communication. Also used in modem connections to verify that systems are ready to receive data (or more data).

Henry - Unit of inductance.

hermetic - Airtight, impervious to external influence, as in a hermetic package. Often used to describe metal-to-metal solder or weld sealed packages. In reality all materials are permeable, hence specifications define acceptable levels of hermeticity.

Hertz - Term for cycles per second by international standard, adopted and now common in U.S. From the German physicist's name, Heinrich R. Hertz. In use we find that 60 cycles/second (or 60 cps) becomes 60 hertz (or 60 Hz).

hexadecimal - A numbering system with the base 16. The digits of the system are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. The addressing of some KVM switch systems rely on hexadecimal coding.

horizontal sync – The synchronization frequency at which the video beam sweeps across the face of a monitor to paint the pixels of each line. Typically measured in thousands of Hz.

hybrid - A blend or composite of two different technologies. The context defines the technologies; for example it may describe a mix of integrated circuit and discrete transistor circuitry.

hybrid IC - A composite of either monolithic integrated circuits, or discrete semiconductor device circuits, in a unit packaging configuration.

Hz - abbreviation. See Hertz.

I

I - Symbol used to designate current.

IC - abbreviation. See integrated circuit.

IEC - International Electrotechnical Commission.

IEEE - Institute of Electrical and Electronics Engineers.

IEEE 488 - An interface standard for interconnecting programmable digital instruments.

impedance (Z) - The total opposition offered by a component or circuit to the flow of alternating or varying current. Impedance is expressed in ohms and is similar to the actual resistance in a direct current circuit. In computations, impedance is handled as a complex ratio of voltage to current.

impedance match - The condition in which the impedance of a component or circuit is equal to the internal impedance of the source, or the surge impedance of a transmission line, thereby giving maximum transfer of energy from source to load, minimum reflection, and minimum distortion.

Imperial Wire Gauge - See British Standard Wire Gauge.

in-band – A reference (in the context of this document) to the remote control of a computer by means of its LAN connection or a modem connection. Such software packages as PC Anywhere™, LapLink™, and Timbuktu™ allow one computer to be viewed and controlled from another by means of in-band communication; if the computer being accessed is locked up or “hung,” the access is not usable. Conversely, out-of-band remote access/control solutions directly address the keyboard, video and mouse ports.

inductance - An electromagnetic phenomenon in which the expanding and collapsing of a magnetic field surrounding a conductor or device tends to impede changes in current. The effects of inductance become greater as frequencies increase. The basic unit of measurement for inductance is the henry. Inductance can be a component of reactance.

inductive coupling - The coupling of energy from one circuit to another that results from the magnetic field generated by the source conductor.

inductor - A circuit component designed so that inductance is its most important property. Also called a coil.

insertion loss - The loss in load power due to the insertion of a component, connector, or device at some point in a transmission system. Generally expressed as the ratio - in decibels - of the power received at the load before insertion of the apparatus, to the power received at the load after insertion.

insulation - A material having high electric resistance making it suitable for covering components, terminals, and wires, to prevent the possible future contact of adjacent conductors resulting in a short circuit.

integrated circuit (IC) - An interconnected array of active and passive elements integrated with a single semiconductor substrate or deposited on the substrate by a continuous series of compatible processes, and capable of performing at least one complete electronic circuit function. Normally, only the input, output, and supply terminations are accessible. Also called monolithic circuit and monolithic integrated circuit. When transistors or other discrete components are separately mounted and connected, it is a hybrid integrated circuit.

Intellimouse™ - Microsoft's trademark for a special type of computer pointing device originally developed by them for use with Windows applications. It consists of a two-button mouse with a small wheel between the two buttons. The wheel is used for scrolling and pointing functions with compatible software applications. Also known as a "wheel mouse." Because it uses different data encoding, it requires different mouse drivers to function. For this reason, only certain late-model KVM switches and extenders can be used with an Intellimouse. Moreover, not all KVM switches allow use of computers whose operating systems probe for such a mouse.

interlaced – Refers to a method of displaying a video image on a monitor or television screen. An interlaced image consists of two sequentially scanned "fields" which together comprise one "frame" of video. Thus, if the video is displayed at 30 fps (frames per second), there are 60 fields per second. The visual impression of a single field is left by a combination of screen phosphor persistence and the psycho-visual blending that occurs within the viewer. Interlaced displays are not as sharp for display of precise text and graphics and are seldom used in computer applications, though they are the standard for conventional television.

I/O (input-output) - Pertaining to the equipment used to communicate with a computer and the data involved. In a KVM switch, this may also refer to the keyboard, video and mouse ports that transfer data to/from the computer or switch system.

J

jack - A connecting device into which a plug can be inserted to make circuit connections.

jacket - A rubber or synthetic covering applied over the primary insulation, braids, shields, cable components, or over the cable itself.

JAN specification - Joint Army-Navy specification.

K

keying - A mechanical arrangement of guide pins, guide sockets, keying plugs, contacts, bosses, slots, keyways, inserts, or grooves in a housing, shell, or insert that allows connectors of the same size and type to be lined up side by side with no danger of making a wrong connection. Keying may also be accomplished by numbering the connectors and matching panel positions, or by using connectors of a different size or color. Under certain circumstances, keying and polarization may be combined in a connector design.

keyway - A slot or groove in which a key engages.

kilo - Metric prefix meaning 1,000.

KVM - Acronym for Keyboard/Video (monitor)/Mouse. May refer to a switch or to the actual peripheral devices for a computer. See KVMS.

KVM Extension – See Extender.

KVMS - Acronym for Keyboard/Video (monitor)/Mouse Switch. A device which enables one (or more) consoles, typically consisting of a video monitor, a computer keyboard and a mouse or similar pointer to control two or more attached computers.

kWh – Kilowatt Hour. A measure of power usage, 1 kWh is 1000 watts dissipated for one hour.

L

LAN - An acronym; see local area network.

LCD - An acronym for liquid crystal display. A multi-element display device consisting of a liquid crystals hermetically sealed between two glass plates. Originally the LCD readout was either dark characters on a dull white background or white on a dull black background. The white could take on a blue or green color if various types of backlighting or tinting were used. Later, color LCD displays were developed and current multi-layer LCD technology permits 24-bit (16 million)-color representation.

leading edge - The leading edge of a pulse is defined as that edge or transition which occurs first. The leading edge of a square-wave signal is usually the transition from a logic 0 to a logic 1.

LED - An acronym for light-emitting diode.

light-emitting diode - A semiconductor diode, generally made from gallium arsenide, that can serve as an infrared or visible light source when voltage is applied continuously or in pulses. LEDs are used as indicators in most KVM switches and may also be used for the transmission of modulated signals in fiberoptic transceivers for KVM extenders. LEDs generally have much longer life than lightbulbs, can turn on/off much faster than other light sources, and are responsive to the polarity of the applied voltage.

link - In general, a connection between two systems or circuits. Also, a complete network to send and receive data via fiber optics, including transmitter, receiver, fiber, and connectors.

load - The device or element in the electrical circuit that absorbs power and converts it into the desired form, such as light, heat, or motion.

local area network - A privately owned, geographically limited network interconnecting electronic equipment, as in an office building to promote distributed processing and local communications. The LAN is the most common means for interconnecting computers (for the purpose of sharing databases, transferring files, and allowing multiple computers shared access to printers or to one World Wide Web connection).

M

Mega - Abbreviated M. A prefix meaning 10^6 , or one million.

memory, random-access - Abbreviated RAM. A storage arrangement from which information can be retrieved with a speed independent of its location in the storage. Generally, RAM is comprised of solid-state devices rather than magnetic tape memory. RAM has read and write capabilities. Some optical devices (CD-RW and DVD-RW) are used as a type of RAM, though this is not generally what is meant when referring to RAM.

memory, volatile - A computer storage medium which is incapable of retaining information without continuous power dissipation.

metric prefixes - A series of prefixes used in the metric system to modify a unit of measure. The most commonly used in electronics are as follows:

giga (G) 10^9
 mega (M) 10^6
 kilo (k) 10^3
 centi (c) 10^{-2}
 milli (m) 10^{-3}
 micro (μ) 10^{-6}
 nano (n) 10^{-9}
 pico (p) 10^{-12}

mho - Unit of conductance. Reciprocal of an ohm. One ampere of current passing through a material under a potential difference of one volt provides one mho of conductance. Also called siemens.

microprocessor - A single chip or small group of chips that contain all the functions of a central processing unit; does not include peripherals.

microwave - That portion of the electromagnetic spectrum lying between the far infrared and conventional radio frequency portion. Frequency range extending from 1 GHz to 300 GHz. Microwaves are usually used in point to point communications because they are easily concentrated into a beam and thus do not waste energy by radiating it in unwanted directions.

milli - A prefix meaning 10^{-3} , or one thousandth. One millivolt would be 0.001 volt.

modal dispersion - The spreading of a light signal in a fiber as a result of the rays following different paths (or modes) down the fiber. This limits the number of pulses that can be sent per second. In multimode fiber (larger core than single mode) rays take many different zigzag paths along the fiber, requiring more time for some signals to arrive at the other end, which causes a smearing (running together) of on-off digital pulses.

mode - The path that a light pulse component can take to travel down a fiber.

modem - A unit that transmits digital signals over a transmission medium, typically over a telephone line. A contraction of modulator/demodulator. Generally, modems convert signals from digital format to analog audio format and vice-versa. Typically, modems include circuits and/or firmware to handle "handshake (establishing a specific type of connection), flow control (making sure buffer memory does not overflow), and error detection/correction.

motherboard - A printed circuit board on which connectors are mounted and interconnections are made with another pc board (daughterboard). A board-to-board application with the motherboard usually being the larger and containing other electronic subassemblies.

multi-console - A K/V/M switch architecture which allows more than one console (i.e., keyboard, monitor and mouse) to access different attached computers at the same time. The first such systems were introduced around 1995.

multimode fiber - A fiber that allows a light signal to take various paths to arrive at the end of the fiber causing some light rays to arrive later than others do.

multiplex - The simultaneous transmission of two or more signals using a common carrier wave or a single path in a transmission system. Early examples would include the transmission of stereophonic fm broadcasts and the conveyance of multiple voices over a single telephone line. In KVM switching and extension products, often a single pair of conductors conveys keyboard, mouse and sometimes even audio data by means of multiplexing these various signals.

N

NAB - Abbreviation for National Association of Broadcasters. For several years, prior to January 1, 1958, it was known as National Association of Radio and Television Broadcasters (NARTB).

nano - A prefix meaning 10^{-9} , which is 0.000000001 or one billionth.

nanosecond - One billionth of a second.

NEC - Abbreviation for National Electric Code. Also, Nippon Electric Company.

NEMA - Abbreviation for National Electrical Manufacturers Association.

node - 1. An electrical zero point. Specifically, a current node is a point of zero current; a voltage node is a point of zero voltage. 2. An end point to any branch of a network or a junction common to two or more branches. Terminals and other equipment that communicate over the network are nodes in a network.

noise - An extraneous signal in an electrical circuit, capable of interfering with the desired signal. Loosely, any disturbance tending to interfere with the normal operation of a device or system. Classes of noise include burst or popcorn noise, intermediate frequency noise at low audio frequencies, white (thermal) noise, etc. Signals from power supply or ground line coupled into an amplifier output may be considered noise.

NO or NC contacts - Normally Open or Normally Closed, meaning the state of the contacts when the control circuit is not energized. These terms are most often used in describing switches and relays.

NTSC - Acronym for National Television Standards Committee, the organization that set the standards for television signal formats in the United States of America. Similar to the function of PAL or SECAM in other countries.

O

ohm - The unit of measurement for electrical resistance. A circuit is said to have a resistance of one ohm when an applied emf of one volt causes a current of one ampere to flow.

on-screen display - see OSD.

operating system - An organized collection of techniques and procedures for operating a computer. Specifically, a software package defined to simplify housekeeping and such routine chores as input/output, disk reading, and data conversion.

operational amplifier (op amp) - Originally, an amplifier to perform mathematical operations. An amplifier with two differentially connected inputs, with high voltage gain, and with one output - which ideally is at zero volts when both inputs are at zero volts. It must also be capable of accepting negative feedback without oscillating. Some video drivers use op amps.

optical fiber - Also called fiber-optic cable. A thin, flexible glass or plastic fiber capable of transmitting light over considerable distances by internal reflection.

OSCAR - An acronym, trademarked by Apex PC Solutions, for on-screen configuration and reporting. Apex' version of an OSD for KVM switching.

oscillator - A device or circuit for producing electric oscillations; specifically a radio-frequency or audio-frequency generator. Used in computers to generate the clock by which operations and data transfers are timed and defined.

OSD - Acronym for on-screen display. In a KVM switch, this is an optional feature that allows selection of computers by means of menus displayed on the monitor. Typically connected computers are given names on the OSD, then selected by name (as contrasted to the use of direct pushbuttons, step-through pushbuttons, or keyboard escape commands). OSD's vary by manufacturer, and many also include security features (password access).

Out-of-band - In the context of this document, this refers to the control of a computer which does not rely on access to it via a modem or LAN/WAN connection. See in-band.

P

packet switching - A data transmission process, using addressed packets of data, whereby the communication channel is occupied only for the duration of the transmission of the packet. Computer networks often transfer data by means of packet switching.

parallel circuit - A circuit in which two or more loads are connected to a single voltage source, at a common point or along a common bus.

parallel operation - In computers, the simultaneous transmission of data on separate lines. For example, all bits of an 8-bit word are sent simultaneously on eight separate lines. Parallel operation can be much faster than serial operation, but requires more circuitry and more complex cabling. Recent very-high speed serial circuits outperform many parallel circuits.

parity - A method by which binary numbers can be checked for accuracy. An extra bit, called a parity bit, is added to numbers in systems using parity. If even parity is used, the sum of all 1's in a number and its parity bit is always even. If odd parity is used, the sum of 1's in a number and its parity bit is always odd. Parity is one of the parameters which must be set when establishing a modem communication or setting up a serial data terminal.

parity bit - A binary digit appended to an array of bits to make the sum of all the bits always odd or always even.

parity check - A technique for detecting errors. It consists of summing the 1's in a specific length of data and recording whether the sum was odd or even in a parity bit line. A single error would change the sum and thus be detected. Stated another way: a check that tests whether the number of 1's (or 0's) in an array of binary digits is odd or even. Some RAM chips include parity checking to reduce the chance of undetected random errors.

passive components - Circuit components which have no gain characteristics, such as capacitors and resistors.

PCM - An abbreviation for pulse code modulation. A scheme by which an analog signal is sampled and converted to a digital signal for transmission or storage.

peripheral equipment - Equipment separate from the main computer; includes all forms of attachments to main computer systems. User peripherals in a K/V/M switch system include (typically) the keyboard, video monitor, and mouse.

pico - A prefix meaning 10^{-12} , or one trillionth.

polyvinyl chloride (PVC) - Thermoplastic compound composed of vinyl chloride polymers. Blended with other polymers or copolymerized with monomers to give abrasion resistance, heat stability, short molding cycles, and low shrinkage. This is used as an insulation in some wires and cables; while it is flexible, it may not be as durable as rubber in constantly flexed cables, and it is not suitable for use in plenums due to its flammability and the toxicity of the smoke it generates when burned.

positive lock - A type of latch or locking mechanism that engages in such a way that the parts cannot be unlocked accidentally. Used to inserts in shells, connectors in mated position, contacts in certain pc board disconnects, etc. The screw-in "D" connectors on some KVM cable sets are considered to be positive locking, as contrasted to typical PS-2 type DIN-6 connectors which can disconnect accidentally under strain.

pot - To embed a component in a material within a casing that becomes part of the product: primarily for protection, though it may be to thwart the theft of circuit details. Alternatively, an abbreviation for potentiometer.

Potentiometer - (pot) A popular term for a variable resistor.

potting - The sealing of a component (e.g., the cable end of a multiple-contact connector) with a plastic compound or material - to exclude moisture, prevent short circuits, provide strain relief, etc. Potted or molded cable ends are generally more durable than those which snap, glue or screw together.

power brick - A small power supply, either a transformer or a transformer plus rectifier, which plugs into an AC outlet and has a cable leading to the device it powers. Power bricks are commonly used on modems and other smaller electronic devices, as well as on some KVM switches and extenders. They are used for a variety of reasons including: less costly to purchase an off-the-shelf supply than to design it into the equipment, removes heat-producing components from the main chassis, removes noise- and hum-generating components from the vicinity of sensitive circuitry, and provides a means to purchase an optional power supply in designs where they are not always needed.

Power PC - Refers to an Apple Macintosh (or other computer as some IBM RS/6000's) using a Motorola RISC based CPU such as the 600-series (603, 603e, 604, 604e) or later on the G3 or G4 CPU.

printed circuit - A conductive pattern, that may or may not include printed components, formed in a predetermined design on the surface of an insulating base in an accurately repeatable manner. The two most common types of printed circuits are etched and plated.

printed circuit board - A plastic, epoxy or similar board substrate, to at least one layer of printed circuitry is applied. The board is usually drilled for component mounting (with or without printed components), and typically is then fitted with separately manufactured parts that are manually or machine soldered in place.

printed circuit edge connector - A connector designed specifically for making removable and reliable interconnections between the terminal area (edge pads) of a printed circuit board and the external wiring.

printed element - An element in printed form, such as a printed inductor, resistor, capacitor, or transmission line. Printed elements can be formed on printed circuit boards along with connections. Also called printed components.

printed wiring - A type of printed circuit intended primarily to provide point-to-point electric connections and shielding. Often this is in the form of a very flexible, plasticized backing coated with metallic conductors.

processor - The computer, especially in data systems involving a number of peripheral devices: frequently referred to as the central processing unit (CPU). That portion of a digital computer which performs the arithmetic, logic, and system control operations.

production model - A model in its final mechanical and electrical design form, and manufactured using production tooling and methods: as contrasted to a prototype, demo or pre-production model.

program - The set of instructions that the computer is directed to carry out in a specified sequence. Also a verb to indicate the process of instructing a computer or a device (such as a KVM switch) to function in a particular manner.

PROM - An acronym for programmable read only memory. A ROM that can be programmed once, but then cannot be reprogrammed.

propagation delay - Time required for an electronic digital device, or transmission network, to transfer information from its input to its output. Also refers to a delay in distribution of a new or changed domain name-to-IP address assignment across the internet.

propagation delay time - The time between the application of a digital input waveform and the corresponding change in output waveform. It is measured between reference points on the waveforms. The time is generally different for positive-going and negative-going waveforms. A difference in the propagation delay times of the red, green and blue signals traveling in different pairs of wires within an interconnect cable generally causes video degradation as cable lengths increase.

protocol - A formal set of conventions or rules governing the format, timing, and error control to facilitate message exchanges among electronic equipment.

prototype - A model suitable for use in complete evaluation of form, design, and performance.

PS2 – Personal (computer) System 2, the second generation of IBM personal computers after the short-lived PS1. More generally, PS2 refers to the type of connectors used for keyboard and mouse ports on most of the PCs manufactured in the late 1990s. A mini-DIN 6-pin connector. These are gradually evolving into USB (universal serial bus) ports instead.

pulse - A change in the level, over a relatively short period of time, of a signal whose value is normally constant. Example: The voltage level of a point shifts from 0 to +12 volts, with respect to ground, for a period of 2 microseconds. Pulses can be noise, or they can represent the 1's and 0's of digital logic.

pulse broadening - The spreading or lengthening of a light pulse in fiber optic cable due to modal or spectral dispersion.

pulse width - The length of time that the pulse voltage is at the transient level. Electronic pulse widths normally are in the millisecond (10^{-3}), microsecond (10^{-6}), or nanosecond (10^{-9}) range.

PVC – Abbreviation for polyvinyl chloride.

Q

queue - Waiting lines resulting from temporary delays in providing service. In computer-related systems, a queue can be a string of instructions or data stored in a buffer and awaiting execution or transmission.

QUIP - An acronym for QUad In-line Package. A packaging technique similar to a DIP but having two rows of pins along each long side, or a total of four rows.

R

R - Symbol used to denote resistance in ohms.

rack - A cabinet used to house components, which permits convenient removal of portions of the equipment for repair or examination. Original racks were standardized steel frames for mounting 19-inch relay panels in telephone exchanges. Today, racks vary in size and shape to meet the specialized requirements of computer, aircraft, military electronics, and test equipment manufacturers. The nominal width of a rack refers to the width of the front panel of equipment to be mounted on the rack rails; typical widths are 19, 23, 24 and 30 inches. Rail hole-to-hole spacing is most often specified by the EIA (electronic industries association).

random-access memory (RAM) - See memory, random-access.

raw data - Data which has not been processed; may or may not be in a computer-compatible format.

RC - Designation for any resistor-capacitor circuit, or a circuit which exhibits the characteristics of resistance and capacitance (since it may not have discrete resistors or capacitors).

read - To copy, usually from one form of storage to another, particularly from external or secondary storage to internal storage; to sense the meaning of arrangements of hardware; to sense the presence of information on a storage medium.

read-only memory (ROM) - A storage arrangement primarily for information retrieval.

real-time operation - Solving problems as fast as they occur so that the results can be used to guide the operation. Transferring data immediately, as it is generated, rather than from stored information.

receptacle - In coaxial RF connectors the receptacle is usually the fixed or stationary one that is mounted on a panel. In shell type multiple-contact connectors the receptacle usually contains the pin contacts and is mounted on the “cold” side of the circuit such as in a drawer or “black box.” Receptacles mate with plugs.

record – (noun) A line of information under a collection of fields.

redundancy - Any deliberate duplication, or partial duplication, of circuitry or information to decrease the probability of a system or communication failure. In a KVM switch system design, redundancy can help assure continuing control of connected servers despite the failure of one or another KVM component.

reflection - The backward transmission of electrical energy caused by a change in impedance. Splices or non-optimized extension connections in high-frequency cables (such as video) can cause unwanted reflections that degrade signal transmission.

reflection coefficient - The fraction of light power reflected backward at the fiber end face of a fiber optic cable. This accounts for about a .2 to .3 dB loss, typically.

register - A memory device capable of containing one or more computer bits or words.

relay - An electrical device that is designed to interpret input conditions in a prescribed manner, and, when specified conditions are met, to respond by causing contacts to operate (or by causing circuits to open or close). Inputs are normally electric, but may be thermal, mechanical, or by other modes. A relay is an electrically operated switch.

relay contact bounce - Undesired intermittent closure of open contacts or opening of closed contacts. This may occur either when the relay is operated or released, or when the relay is subjected to external shock or vibration. The term “bounce” is normally associated with internal causes.

repeater - A device that receives, amplifies and otherwise reconditions, and retransmits a signal. Some KVMS switches use repeater circuitry to convey control and video signals over longer distances from chassis to chassis.

resistance - The property of a body which opposes and limits the passage of a steady electrical current through it.

resistor - A circuit component which offers resistance to the flow of electric current. Its electrical size is specified in ohms or megohms (1 megohm = 1,000,000 ohms). A resistor also has a power-handling rating measured in watts, which indicates the amount of power which can safely be dissipated as heat by the resistor.

resonance - The frequency at which capacitive reactance and inductive reactance are equal and therefore cancel one another's effects.

RETMA - Abbreviation for Radio-Electronics-Television Manufacturers' Association. Now changed to Electronics Industries Association (EIA).

rf - Abbreviation for radio frequency.

RGB – Abbreviation for Red-Green-Blue, the primary phosphor colors in most color video and television monitors. Also refers to a means of representing the color spectrum within computer programs and files. Used for radiated or transmissive color, not for reflective color representation.

RG/U - RG/U is used to designate coaxial cables that are made to a Government specification. In the case of RG58/U, the “R” means RADIO FREQUENCY, the “G” means GOVERNMENT, the 58 is the number assigned to Government approval, and the “U” means it’s a UNIVERSAL specification. Some video signals are better conveyed over longer distances by coaxial cables, and these are specified by RG/U values.

ribbon cable - Round conductor flat cable. A form of flexible flat cable consisting of parallel round conductors in a flexible insulating material and designed for mass termination.

ring network - A network topology in which nodes are connected as point-to-point links in an unbroken circular configuration.

RISC – Acronym for Reduced Instruction Set Computer, a type of computer CPU that has a smaller internal set of programming instructions than CISC (complex instruction set computer) but which runs faster because of it and provides (generally) faster overall computational power than CISC computers. The IBM RS/6000 series and Apple Macintosh Power PC series, among others, utilize RISC CPUs.

rms - See root mean square.

ROM - Read-only memory. A memory, usually a semiconductor chip, in which the information is permanently stored. ROMs offer random-access read capabilities. May be programmed during manufacture or by the user. Some are reprogrammable. See PROM and EPROM.

root mean square - The effective value of an alternating current, corresponding to the direct current value that will produce the same heating effect.

rotary switch - A multiposition switch operated by rotating a control knob (attached to its shaft) either clockwise, counterclockwise, or both.

RS -232, -422, -449 - A series of standards defining the physical link between units of data communication equipment. The most common serial interface is probably RS-232.

RU – Rack Unit. An EIA-standard for vertical measurement in a telecommunications or computer rack (or cabinet). One RU equals 1.75 inches, two RU is 3.5 inches and so forth. Due to the additional space needed for framing, a cabinet may be specified to be 84 inches tall and 44 RU; while 44 x 1.75 inches is 77 inches, that represents the usable rack mounting space, whereas the 84 inches represents the overall external height.

S

safetying - A term used to cover the use of product features designed to prevent the loosening of hardware, or other mating elements, under conditions of shock and vibration. Elements drilled for safety wiring would be an example of this type of feature. In a very general sense, a locking connector is a means of safetying a KVM cable to the switch.

scanner - An electromechanical or electronic device, normally cyclic in nature with N number of steps - starting at a predetermined point and returning to that same point. Scanning in a KVM switch refers to the automatic switching from one CPU to the next without user intervention; this is useful for casual monitoring of multiple systems (as on a large display monitor).

schematic - A “scheme” for presenting information. Thus, a circuit schematic - in diagrammatic form - indicates the components, wiring, and connections of the circuit.

Schmitt trigger - A bistable trigger circuit that converts an input signal into a square-wave output signal by switching action, triggered at a predetermined point in each positive and negative swing of the input signal.

Schottky TTL - A type of TTL (transistor-transistor logic) notable for faster operating speeds than standard TTL.

scratch pad memory - A computer memory that interfaces directly with the central processor. It is optimized for speed and has a limited capacity. Its purpose is to supply the central processor with the data for the immediate computation without the delays that would be encountered by interfacing with the main memory. Also known as cache memory.

SDLC - An IBM data-communication protocol.

sector - The smallest addressable unit of information (set of bits) in a rotating computer memory (such as hard disk, floppy disk or CD/DVD).

semiconductor - Materials whose electrical conductivity is between that for good conductors and that for good insulators. Their conductivity may be changed by heat, light, electric field, or magnetic field. The intentional “doping” with specific impurities may also change them. Examples include: germanium, lead sulfide, lead telluride, selenium, silicon, and silicon carbide. A semiconductor device, such as a transistor, is frequently referred to simply as a “semiconductor.”

semi-rigid - A cable containing a flexible inner core and a relatively inflexible sheathing.

sensitivity - Measure of the ability of a device or circuit to react to a change in some input. Sensitivity can also be the minimum or required level of an input necessary to obtain rated output, as in an amplifier.

serial operation - The flow of information through a device in time sequence - using only one digit, word, line, or channel at a time. For example, all bits of an 8-bit word are transmitted one bit at a time over a single line.

serial transfer - Data transfer in which elements of information are transferred sequentially.

series (circuit) - Connecting components in a circuit end-to-end to provide a single path for current flow.

series (topology) - A computer or switch network layout in which the various components are linked one to the next. Also known as a daisy chain.

server - a computer which hosts (holds) a database, application program, or other files and makes them available for access by other computers (the “clients”), typically via a Local Area Network (LAN) connection.

server farm - A collection of servers in one physical area, typically in a data center.

SGI - Silicon Graphics Incorporated, a maker of specialized computers and software often used for high-resolution graphics, map making, film/video special effects and animation.

sheath - The outer covering or jacket over the insulated conductors to provide mechanical protection for the conductors. Also known as the external conducting surface of a shielded transmission line.

shell - An encapsulation for inserts or modules. Mating shells usually provide proper alignment and protection for the contacts enclosed in the inserts or modules.

shf - See superhigh frequency.

shield/shielding - A conducting envelope, composed of metal strands, that encloses a wire, group of wires, or cable, so constructed that substantially every point on the surface of the underlying insulation is at ground potential or at some predetermined potential with respect to ground.

An isolation barrier placed around a circuit component to prevent interaction of its electric and/or magnetic fields with those of nearby elements.

signal-to-noise ratio - The ratio of signal strength to noise level in an electronic system.

significant digit - A digit that contributes to the preciseness of a number. The number of significant digits is counted beginning with the digit contributing the most value, called the most significant digit, and ending with the one contributing the least value, called the least significant digit.

silicon - The semiconductor material most widely used for transistors, diodes, and monolithic integrated circuits. A brittle, gray, light metal.

silicon-controlled rectifier (SCR) - A semiconductor device capable of only two stable states. When "off," it blocks the flow of electricity in either direction. A small triggering voltage to its gate turns it "on," and allows the flow of electricity in the forward direction only. When "on," the SCR acts just like a conventional rectifier. To turn it "off," voltage to the anode must be removed, or reduced to a potential less than that being applied to the cathode.

simplex - A circuit which allows telecommunications in only one direction at a time; a one-way path for telegraph-type signals.

Sine wave - A wave which can be expressed as the sine of a linear function of time, space, or both. A waveform (often viewed on an oscilloscope) of a pure alternating current or voltage.

single mode - A fiber optic fiber that allows only one path for the light to take due to the fiber's very small diameter - less than 10 microns.

single-pole - A contact arrangement wherein all contacts, in one position or another, connect to one common contact.

skin effect - The tendency of alternating currents to flow near the surface of a conductor, thus being restricted to a small part of the total cross-sectional area. This effect increases the resistance, and becomes more marked as the frequency rises.

sleeve - The insulated, or metallic, covering over the barrel of the terminal.

small-scale integration - Abbreviated SSI. A single circuit function implemented in monolithic silicon. In complexity, a circuit of less than 10 gates.

SMD - See surface mount device.

SNR - See signal-to-noise ratio.

solder - An alloy that can be melted at a fairly low temperature, for use in joining metals having much higher melting points. An alloy of tin and lead in approximately equal proportions is the solder most often used for making permanent joints in circuits. Electronic components are soldered with rosin as a flux; plumbing solder with acid flux will quickly destroy electronic circuits due to oxidation.

solid state - The use of semiconductor materials, in place of vacuum tubes, to perform the functions of

step index - A fiber construction where the core is one distinct index of refraction and the cladding a lower one causing the light to travel down a fiber by reflecting off the core-cladding interface.

strain-relief clamp - A device used to give mechanical support for the contacts from the weight of a wire bundle or cable.

strip - To remove insulation from a wire or cable.

SUN – A manufacturer of powerful workstations and servers, as well as a developer of operating systems and other software for their own and other companies' computers.

superhigh frequency (shf) - A Federal Communications Commission designation for the band from 3,000 to 30,000 MHz in the radio spectrum.

surface-mount device - An electronic component, ranging from discrete passive components to VLSI chips, attached to the surface of a printed circuit board, either directly or through a surface-mount connector, rather than by means of holes in the board.

surge - A transient variation in the current and/or potential at a point in the circuit.

SVGA- Super VGA (see VGA). A higher-resolution version of VGA video that is typically 1024 horizontal by 768 vertical pixels, but may refer to higher resolutions of 1280 H x 1024V or even 1600 H x 1200 V pixels, though the latter may also be known as XGA.

swedging - Another term for crimping.

switch - A mechanical or electronic device used to make or break an electrical circuit.

synchronize - Make sure that the level or pulse is presented to the system, or subsystem, at the correct time. With KVM systems, mouse or keyboard synchronization assures that motion of the mouse (or keystrokes) convey the intended (controlling) bytes of data to the selected computer.

synchronous - A device or system in which all events occur in a predetermined timed sequence. Usually all parts operate to a common clock.

synchronous transmission - Transmission in which the data characters and bits are transmitted at a fixed rate with the transmitter and receiver synchronized.

T

tactile feedback - The feel or snap action of certain constructions of keyboards. A new type of mouse is intended to give the user "virtual" tactile feedback by interacting with elements on the computer's displayed windows. It is unlikely any current KVM switch will accommodate such mice (or computers using the specialized drivers for these mice) because special firmware would be required in the switch and the mouse was just introduced in 2000.

TDM – Abbreviation for time-division multiplexing.

Tempest - A classified Department of Defense program to provide secure electronic equipment through extensive EMC techniques (Electro-Magnetic Cladding).

terminal - An electrically conductive item designed to be attached to a circuit or device for convenience in making electrical connections. Also, a data terminal -- typically a CRT with character generator drive circuitry to display text from an serial ASCII data stream, plus a keyboard to send ASCII serial data back to the controlled device or system.

terminus - A part of a fiber-optic connector analogous to a contact.

time-delay - A circuit that delays the transmission of an impulse a definite and desired period of time.

time-division multiplexing - A technique used in data communications technique for combining several lower speed channels into one transmission path at higher speed in which each low-speed channel is allotted a specific position based upon time in the signal stream.

tinning - A hot dip process for the application of solder coating on conductors and terminals primarily for minimizing in-process oxidation and enhancing solderability. Cables provided with tinned leads are ready to be soldered but do not yet have attached connectors.

toroid - A coil or transformer wound on a donut-shaped core. The toroidal core gives a maximum magnetic field within itself, with minimum magnetic flux leakage externally.

track - The portion of a moving storage medium, such as a tape, disc, or card, that contains the encoded data.

transients - Undesirable voltage and current surges that are usually caused by capacitive or inductive energy discharges in electrical circuits.

TTL (T2L) - Transistor-transistor logic. A popular bipolar logic family based on a multiple-emitter transistor. Compared to MOS logic, TTL is generally faster, although it uses more power and offers less packaging density. Older computer video display technology such as MDA, CGA and EGA used a digital signal based on TTL-compatible voltage levels.

U

uhf - See ultra-high frequency.

UL - Underwriters' Laboratories, Inc. An independent laboratory that tests equipment to determine whether it meets certain safety standards when properly used. UL does not certify equipment; they merely list it as being compliant if it meets the particular standard for which it is listed.

ultrahigh frequency (uhf) - A Federal Communications Commission designation for the band from 300 to 3000 MHz on the radio spectrum. In television, channels 14 to 83, or 470 to 890 MHz.

ultrasonic welding - Process using vibratory mechanical pressure at ultrasonic frequencies (20 to 40 kHz) to provide heat for welding some types of thermoplastics.

uniform resolution map - a term we invented to describe a printed graphic representation of the number of horizontal and vertical pixels on a displayed image. This is not actually the number of lines or dots, but merely a way to show the relative density of dots on a given image when comparing various resolutions. An aid to visualization only.

UNIX - A popular operating system originally developed by Bell Labs. Today Unix and its variants are widely used in internet-related applications due to the excellent multi-tasking capabilities and security features of this O/S.

USB - Acronym for universal serial bus. A set of serial port standards and connectors promulgated in the late 1990s for medium-speed data communications in small computer systems. USB connections are used for keyboards, mice, graphics tablets, scanners, modems, printers, digital still cameras and some slower mass storage media. They are not suitable for high-speed video, hard disk access and so forth. USB was meant to replace PS2 I/O connections as well as a limited variety of traditional serial port, parallel port and SCSI port connections.

user access ratio - A mathematical expression of the number of users (people actively using a keyboard, monitor and mouse) to the number of available computers in a given KVM switch system. This is not necessarily the same as console access ratio since there can be more console connections than are actually used at once.

UV - Abbreviation for Ultraviolet.

V

voltage (Symbol E) - The term most often used to designate electric pressure that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points. Voltage is measured in volts, millivolts, microvolts, and kilovolts. The terms electromotive force, potential, potential difference, and voltage drop are all often called voltage.

voltage drop - The voltage developed across a component or conductor by the flow of current through the resistance or impedance of that component or conductor. Often simply called voltage. Also called “drop.” The voltage across a resistor is usually called IR drop, while that in a conductor is usually called resistance drop.

voltage regulator - A circuit capable of generating from a varying input voltage a constant output voltage to a varying load current.

vswr - Abbreviation for voltage standing wave ratio. See also standing wave ratio.

VW-1 - A flammability rating established by Underwriters’ Laboratories for wires and cables that pass a specially designed vertical flame test, formerly designated FR-1.

W

wafer - A thin, polished slice of single crystal silicon, on which monolithic integrated circuits are fabricated.

WAN – Acronym for wide area network. Similar to a LAN (local area network) but extending beyond the physical boundaries of a single building or a small physical area. WANs may take advantage of internet links, private telecommunications links, microwave or infra-red relay, or extended gateways between multiple LANs to link more distant computers for the types of access normally provided by a LAN.

watt - Abbreviated W. The practical unit of electric power. In a dc circuit, the power in watts is equal to voltage multiplied by current. In an ac circuit, the true power in watts is effective voltage multiplied by effective current, then multiplied by the circuit power factor. There are 746 watts in 1 horsepower.

wattage rating - A rating expressing the maximum power that a device can safely handle continuously.

wavelength - The distance between two points which are in phase on adjacent waves. It is the distance traveled by a wave in a time of one cycle. Electromagnetic waves (both light and radio) have a speed in space of about 300,000,000 meters (186,000 miles) per second. Thus, wavelength in meters is equal to 300,000,000 divided by the frequency.

wave soldering - An automatic soldering method whereby the molten solder is pumped from a reservoir through a spout to form a head or wave. A circuit board is then passed over the wave by a conveyor, and all components and leads are almost instantly soldered in place by the wave of molten solder. Previously applied resist (a chemical coating) prevents solder from adhering where it is not wanted; after soldering the resist is washed off.

Winchester disk - A type of hard disk drive in which the read/write head is held a few millionths of an inch above the disk whenever the disk is spinning and the head is moved laterally by a “voice coil” type solenoid.

wire - A single bare or insulated metallic conductor having solid, stranded, or tinsel construction, designed to carry current in an electric circuit.

wire size - See American Wire Gauge, and circular mil area.

Wire Wrap - Trademark of the Gardner-Denver Corp for a wrap-type termination.

word - A set of bits constituting the smallest addressable unit of information in a programmable memory.

word length - The number of bits in a word.

write - To deliver data to a medium such as storage.

WYSIWYG – An acronym for what you see is what you get. Refers to the accuracy of an on-screen representation on a computer of a printed page, both in dimensions and character/image shape. Typically WYSIWYG resolution requires a pixel density of 72 dots per inch (where one dot equals one point) though it can be almost-WYSIWYG at up to 80 dpi (a slightly reduced size image).

XYZ

X - Letter symbol used to represent reactance (not resistance) in ohms; reactance is the opposition to the flow of alternating current, as contrasted to resistance, the opposition to the flow of direct current.

XGA – Extended Graphics Array (or Adaptor). A higher-resolution video card and standard; a version of VGA and SVGA, typically 1280 horizontal by 1024 vertical pixels. XGA video typically makes use of “sense” lines returning information from the monitor to the computer so the computer “knows” the size and resolution of the screen image it must render.

XT- Refers to the IBM PC-XT, an early PC.

Z - Letter symbol used to represent impedance in ohms.

zener diode - Normally used to regulate voltage. A p-n junction diode reverse-biased into the breakdown region; provides high impedance to applied voltages of less than breakdown magnitude. When breakdown voltage is reached, an avalanche effect causes the device to conduct with virtually no impedance.

zero voltage switch - A circuit designed to switch “on” at the moment the ac supply voltage crosses zero. This technique minimizes the radio frequency interference generated at switch closure.

ZIF (Zero Insertion Force) - A component designed to eliminate the insertion and withdrawal forces during engaging and separating.

Who Created This Document?

The KVMS White Paper was originally written and revised by Anthony A. De Kerf, president of Tron International, Inc. and by Gary D. Davis, president of The WorkCenter Corporation.

Both firms have specialized in designing computer rooms and testing labs since 1989, with an emphasis on the use of Keyboard/Video Switches to maximize the capacity of available floor space and optimize work flow. In fact, when the concept of Keyboard/Video Switching was in its infancy – with only a few available brands – Tron International was a pioneer in the installation of KVMS products in large computer labs and multi-server environments.

Today, both firms provide engineering, sales, installation, and technical support services for a variety of manufacturers KVMS products. When you consider the use of a KVMS, it is important to know if the manufacturer provides related products, such as sharing devices, to most efficiently utilize the product's features.

Our technically oriented people are familiar with the LAN administrator's responsibilities. If you have an application that you feel involves an unavailable (as yet undeveloped?) product, we suggest discussing the application with the authors of this paper — they may know whether a particular vendor has a suitable new product or one in development. On more than one occasion, customer consultations and the field engineering efforts of our firms, have resulted in manufacturers creating new or modified products to meet the newly identified need.

If you have initially had a negative impression of the whole concept of KVMS, you are not alone. Be aware, though, that many delighted users of KVMS were initially skeptical.

The authors have expended substantial efforts to be comprehensive, accurate and unbiased in the representations within this document. If you are aware of a specific inaccuracy or a significant omission, please contact the authors; valid and pertinent input will be welcome and will find its way quickly into a revised document.

Tron International and The WorkCenter employ special technique's to design KVM Switch Systems into KVM Networks™. We help you configure an array of products to meet the special needs of a broad spectrum of users - each product designed to represent equality in the actual deployment of throughput and user accessibility.

If you would like information on a specific product, or consultation regarding a particular application, please contact:

tron.com

Tron International, Inc.

PO Box 25596

San Mateo CA 94402-5596

650 525-2700 Tel

650 525-2707 Fax

800 808-4672 Toll Free

Info@tron.com

www.tron.com



The WorkCenter Corporation

The WorkCenter Corporation

1206 Appleton Way

Los Angeles, CA 90066

310 737-7530 Tel

310 737-7531 Fax

800 526-6625 Toll Free

Sales@TheWorkCenterCorp.com

www.TheWorkCenterCorp.com